PATENTING DEEP LEARNING

Deep learning technology has been gaining wide spread momentum in the artificial intelligence (AI) community. With more sophisticated AI engine architectures, model training algorithms, and self-executing applications, questions concerning patentability are at the forefront of AI and patent law policy. Now, as AI has important implications for business and national innovation strategy, the time is ripe for examining justifications for exclusive rights in deep learning in order to develop ample incentives to foster the long-term goal of general-purpose AI. To that end, this Article introduces "dynamicism" to identify tensions with overbreadth of method patent claims and related challenges with disclosure and possession of the deep learning invention. The Article draws upon economic theories underlying the patent system to propose a modified prospect theory justification for a more holistic AI innovation law and policy framework.

PATENTING DEEP LEARNING

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INTRODUCTION

The question of how the U.S. patent system should promote the reliability and predictability of artificial intelligence (AI) inventions is an important one, for AI possess enormous innovative potential.[1] AI has been dubbed the fourth industrial revolution[2] and is considered central to economic growth[3]. Research and investment in AI is growing rapidly, and there is a race among large technology corporations and startups to secure patents on AI.[4] The technological progress of AI has been fueled by advances in algorithms, exponential growth in the availability of data, and improved computing power.[5] Though the applications and business implications of AI are impressive, there remain unresolved questions over AI patentability. What, for instance, is the best patent policy for incentivizing AI inventors?

The United States Patent & Trademark Office (USPTO) is seeking to address this question and has requested comments on patenting of AI inventions.[6] USPTO Director Andrei Inacu has remarked that "AI has significant implications for the law, the economy, and America's position as the global innovation leader" and that "As director of the USPTO, one of [his] top priorities is making sure that the United States continues its leadership when it comes to innovation…including AI and machine learning."[7] Furthermore, legal scholarship has begun to discuss issues concerning the role of patents for AI technologies.[8] Practicing attorneys have recognized that patents are

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[1] Executive Order: Maintaining American Leadership in Artificial Intelligence (February 11, 2019); The National Artificial Intelligence Research and Development Strategic Plan: 2019 Update, A Report by the Select Committee on Artificial Intelligence of the National Science & Technology Council (June 2019).

[2] Artificial Intelligence Collides with Patent Law, Center for the Fourth Industrial Revolution, World Economic Forum (2018).

[3] Jason Furman and Robert Seamans, *AI and the Economy*, NBER Working Paper No. 24689 (2018); James Bessen et. al., *The Business of AI Startups*, Boston University School of Law, Law and Economics Research Paper (2018).

[4] Artificial Intelligence Collides with Patent Law, Center for the Fourth Industrial Revolution, World Economic Forum (2018) at 5.

[5] Artificial Intelligence Collides with Patent Law, Center for the Fourth Industrial Revolution, World Economic Forum (2018) at 5.

[6] Request for Comments on Patenting Artificial Intelligence Inventions, United States Department of Commerce: Patent & Trademark Office, Federal Register, Vol. 84, No. 166 (August 27, 2019).

[7] Andrei Inacu, Remarks by Director Iancu at the Artificial Intelligence: Intellectual Property Considerations event (January 31, 2019).

[8] Brenda M. Simon & Ted Sichelman, *Data-Generating Patents*, 111 NW. L. REV. (2019); Charlotte A. Tschider, Presentation at Intellectual Property Scholars Conference at DePaul University College of Law: Patenting Artificial Intelligence (August 8, 2019); Ana Ramalho Patentability of AI-Generated Inventions: Is a Reform of the Patent System Needed?, available at https://ssrn.com/abstract=3168703 , Daniel Gervais Exploring the Interfaces Between Big Data and Intellectual Property Law, 10

important to their technology clients' business strategy and have provided high-level guidance.[9] Yet neither the USPTO, legal scholarship, nor practicing attorneys have addressed the distinctions and uniqueness of deep learning, a form of artificial intelligence, that poses new thought questions for U.S. patent law. This Article extends beyond the cursory and superficial references to AI to consider a contemporary and in-depth conception of AI and how patentability may or may not encourage deep learning innovation.

Deep learning is immensely important to present day business and future innovation, yet understudied in legal scholarship; applications as diverse as in autonomous vehicles, cyber security, financial forecasting, medical diagnosis and informatics, and retail are literally transforming society. Deep learning refers to black box systems that enable automatic insights of patterns from unstructured, high-dimensional data.[10] Unlike traditional AI machine learning techniques, deep learning is considered a universal learning approach that increases its performance with respect to the greater amounts of data.[11] The superiority of deep learning over legacy AI techniques stems from its hierarchical, layered architecture that exceeds the human brain's ability observe, analyze, learn, and make decisions for complex problems that generate learning patterns and relationships beyond the immediate data.[12]

This Article seeks to explore the significant kind of innovation as well as its divergence from legacy AI championed by deep learning. In a broader sense, this Article argues that legal scholarship on AI[13] has been hyped[14] and undefined[15]; scholars have erroneously referenced legacy and outdated AI, when in fact modern day AI is deep learning, and have superficially focused on models and systems, when in fact the key issues concern algorithms and engines. Although previous legal scholarship has recognized doctrinal challenges with AI, including with

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Journal of Intellectual Property, Information Technology and Electronic Commerce Law 22 (2019); 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 (2018).

[9] Brian Higgins, *The Role of Explainable Artificial Intelligence in Patent Law*, Intellectual Property & Technology Law Journal (March 2019); Christopher J. White and Hamid R. Prioozi, *Drafting Patent Applications Covering Artificial Intelligence System*, American Bar Association (2019); Protecting Artificial Intelligence IP: Patents, Trade Secrets, or Copyrights?, Jones Days, (2019); Michael Borella, *How to Draft Patent Claims for Machine Learning Inventions* (November 25, 2018), Michael Borella, *The Subject Matter Eligibility of Machine Learning: An Early Take* (September 23, 2018), Protecting Artificial-Intelligence Systems Using Patent Applications, American Bar Association (Jan. 1, 2017); Ben Hattenbach & Joshua Glucoft, Patents in an Era of Infinite Monkeys and Artificial Intelligence, 19 STAN. TECH. L. REV. 32 (2015).

[10] Saptarshi Sengupta et. al., A Review of Deep Learning with Special Emphasis of Architectures, Applications and Recent Trends, IEEE Transactions (2019).

[11] Zahangir Alom et. al., A State-of-the-Art Survey on Deep Learning Theory and Architectures, Journal of Electronics MDPI, (2019).

[12] Maryam M. Najafabadi et. al., Deep Learning Applications and Challenges in Big Data Analytics, Journal of Big Data (2015) at 4.

[13] Catalina Goanta et. al, *Back to the Future: Waves of Legal Scholarship on AI,* forthcoming in *Time, Law and Change* (Oxford, Hart Publishing) (2019).

[14] Clark D. Asay, *Artificial Stupidity*, 61 WM. & MARY L. REV. (2020).

[15] Jonas Schuett, A Legal Definition of AI, available at https://ssrn.com/abstract=3453632 (2019); Harry Surden, *Artificial Intelligence and Law: An Overview*, 35 GA. ST. U. L. REV. (2019); Mark A. Lemley and Bryan Casey, You Might be a Robot, Cornell L. Rev. (2019).

inventorship[16] and with patentability for patent eligibility,[17] nonobviousness,[18] and enablement,[19] this Article represents the first comprehensive examination of patenting deep learning and provides a more modern and interpretive descriptive view encompassing unique technological foundations.

As a descriptive matter, deep learning is an advanced field of machine learning, which is a subset of artificial intelligence. In essence, deep learning teaches a computer program to identify patterns in data and to apply the knowledge to new data. Deep learning's technological uniqueness, centers on its processes existing in different variations, depending upon the data that is built upon. A theme of this Article is that variability of deep learning causes tensions with patent law principles that are rooted in the physical world and do not account for the dynamic nature of deep learning stages. The first sage of deep learning requires a model architecture to be programmed. Second, a model is developed through a training process that utilizes training data sets. Third, the trained model is applied to new output. The dynamic nature of deep learning is two fold—(1) the ability to have new output based with each application of new data, and (2) the variety of possible output, including correlation, clustering, and prediction. The thesis of this Article is that the sources of doctrinal patentability tensions stem from these inherent dynamic characteristics, which do not fit within the patent law principles that are rooted in the physical world.

A natural, next response is to inquire whether patents are even needed by deep learning inventors. Trade secret protection is a viable alternative to patent protection. A patent system that lacks clarity and predictability regarding the scope of patent protection would lead innovators to seek trade secret protection. To compound this dilemma further, certain types of digital technologies enable an innovator to pursue both patents and trade secrets. Scholars have called this phenomena as data-generating patents,[20] which refers to inventions that generate unique data from users and can generate large amounts of data about the world in general, and in doing so, improve the operation of the invention. Deep learning technology is a technological domain where data generating patents could be present and prevalent. As a result, patents are a consideration for some aspect of deep learning, even if trade secrecy is pursued for other aspects. While trade secrecy is a viable possibility for deep learning technology, patent activity has been relatively high and continually growing in this realm. In fact, patent claims directed to machine learning has risen

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[16] W. Michael Schuster, *A Cosean Analysis of Ownership of Patents for Inventions Created by Artificial Intelligence*, 75 WASH. & LEE L. REV. 1945 (2018); Robin Feldman and Nick Thieme, *Competition at the Dawn of Artificial Intelligence*, forthcoming J. OF ANTITRUST ENFORCEMENT (2018); Shlomt Yanisky Ravid and Xiaoqiong Liu, *When Artificial Intelligence Systems Produce Inventions: The 3A Era and an Alternative Model for Patent Law*, CARDOZO L. REV. (forthcoming 2018); Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 57 B.C.L. REV. 1079 (2016).

[17] Mizuki Hashiguchi, *The Global Artificial Intelligence Revolution Challenges Patent Eligibility Law*, 13 J. BUS. & TECH. L. 1 (2017).

[18] Liza Vertinsky, *Thinking Machines and Patent Law*, RESEARCH HANDBOOK ON THE LAW OF ARTIFICIAL INTELLIGENCE, (forthcoming 2018); Ryan Abbott, *Everything is Obvious*, 66 UCLA L. REV. 2 (2018).

[19] Alfred Früh, *Transparency in the Patent System: Artificial Intelligence and the Disclosure Requirement* (Jan. 3, 2019) available at: https://ssrn.com/abstract=3309749

[20] Brenda M. Simon & Ted Sichelman, *Data-Generating Patents*, 111 NW. L. REV. 377, 379 (2017).

sharply in recent years, approaching nearly to exponential growth rate.[21] Despite the high patent activity of deep learning inventions, this Article asserts that, as a doctrinal and statutory matter, deep learning technology has tensions with the patentability requirements that require reassessment from theoretical and policy lenses.

This Article analyzes the inherent difficulty of patenting deep learning. Significantly extending previous scholarship, this Article argues that doctrinal patentability tensions of AI in a broader sense and of deep learning in specific sense stems from difficulties with capturing a series of steps of an AI algorithm into a method patent claim. It delves deeper than descriptive accounts of AI to provide a theoretical explanation of antiquated views of method patent claims as generating some sort of product.[22] This Article introduces the term "dynamicism" in the context of deep learning patents. Dynamicism as used in this Article is the view that the invention exists outside of what is claimed in the patent—the physical embodiment of the invention changes from its trained state, for which new data can be applied to generate a new output. Dynamicism describes a manifestation of the deep learning invention that goes beyond gerund steps of the method patent claim format in the patent itself.

The core facet of a method patent claim is a series of steps for performing a function or accomplishing a result.[23] The method patent claim refers either to a series of steps in a manufacture or to a way of using a product to achieving a result. The series of steps or way of using a product that is inherent in a method patent claim can be depicted by a flow chart and described in a gerund format, which is a verb of the "-*ing* form." Either of these descriptions of method patent claim represent a transformation from an initial state to a final state. The description of the claimed invention in a method patent claim involves one or more interim states that represents a change from the prior step and necessitates a change to attain the subsequent steps. In contrast, a deep learning invention, when referring to a machine learning model, does not necessarily attain a final step. A deep learning invention can take in new data as input to generate a certain output, such as identifying a correlation between data points, clustering, or making a prediction. Moreover, the output from a machine learning model of a deep learning invention can be different practical uses. As such, the method patent claim format cannot adequately capture a deep learning invention's ability to generate new outputs or different practical uses.

A machine learning model, which is developed through a training process, can be described either with a gerund (*ing* form) or with a past tense verb. For example, in a first scenario, a machine learning model of a deep learning invention can be described in a method patent claim as the series of steps required to attain a trained model. For example, in a second scenario, a machine learning model of a deep learning invention can be described in a method patent claim as using the final trained step. In either scenario, the physical manifestation of the invention changes, or is dynamic, since the addition of new data to trained model would yield an outcome that will represent a change

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[21] Dean Alderucci, Mapping the Movement of AI Into the Marketplace with Patent Data, Carnegie Mellon University; Tom Simonite, Despite Pledging Openness, Companies Rush to Patent AI Tech, WIRED (July 2018).

[22] Timothy R. Holbrook, Method Patent Exceptionalism, 102 IOWA L. REV. 1001 (2017) at 1016.

[23] Gottschalk v. Benson, 409 U.S. 63, 70 (1972).

from the trained state. A patent that claims a trained machine learning model of a deep learning invention cannot capture the result of new data entering the trained model. Due to its "black box" nature, a trained machine learning model of a deep learning invention cannot be described in a method patent claim since there is not knowledge of the precise output based on a given input.

A method patent claim does not necessarily cover something physical, but instead covers the steps of a process.[24] The method patent claim covers the act of performing some step or action, which can be applied to a physical object. As a result, a method patent claim represents an effort to patent something beyond the physical aspect of the invention and covers an act that is intangible.[25] The acts involved in method patent claims are fleeting in nature, since they lack a physicality associated them, and as a result, represent something intangible over an intangible property right. Thus, since there is an inherent gap between the intangible nature of the process in a method patent claim and its physical instantiation, there is a concern with method patent claims that there is the potential for overbreadth. Whereas in the industrial age, where the focus was on tangible means,[26] with information technologies (such as deep learning), the process steps have the inherent ability to capture instantiations beyond the invention.

The lack of explainability and interpretability of the deep learning invention represents the dynamic manifestation of entering new data to a machine learning model. Notably, patent law would view these deep learning examples as existing outside of the patent document. Put another way, invention, through the eyes of dynamicism, lacks physical manifestation of the invention. Dynamicism in the deep learning sense means that an invention does not exist physically until and unless fed with new data. Method patent claims present challenges for how the patent system should demonstrate possession of the algorithms, data, and models—the very facets of deep learning inventions.

Moving from the descriptive to the normative, this Article draws upon economic theories underlying the patent system to propose a modified prospect theory justification for patenting deep learning, in order to enhance reliability and predictability, though it may produce a departure from technology neutrality of U.S. patent law.[27] Accordingly, it offers prescriptions for capturing the unique considerations to deep learning inventions. This Article proceeds in four parts.

Part I explores the predominant technology conception of AI and argues that doctrinal patentability tensions arise from the intangible, expansive nature of method claims.[28] Justice Kennedy of the U.S. Supreme Court had remarked in *Bilski v. Kappos* on the unique, troubling aspects of methods and processes in the electronic and digital age by stating, "The Information Age empowers people with new capacities to perform statistical analyses and mathematical calculations with a speed an sophistication that enable the design of protocols for more efficient performance of a vast number of business tasks." Although Justice Kennedy's referred to business

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[24] Timothy R. Holbrook, *Method Patent Exceptionalism*, 102 IOWA L. REV. 1001, 1003 (2017).

[25] Timothy R. Holbrook, *Method Patent Exceptionalism*, 102 IOWA L. REV. 1001, 1003 (2017).

[26] Elizabeth Winston, *Information Age Technology, Industrial Age Laws*, TENN. L. REV. (2019).

[27] Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1156 (2002)

[28] Timothy R. Holbrook, Method Patent Exceptionalism, 102 IOWA L. REV. 1001 (2017) at 1059.

methods, he foreshadowed that method patent claims permit potential overbreadth and capture of fleeting and intangible steps.[29] This Article presents a descriptive theory of patent method claims, which it contends do not adequately capture unique characteristics of deep learning inventions, and as a result, raise doctrinal tensions with enablement, patent eligibility, and non-obviousness. The result is that deep learning inventors face the choice of patent method claim drafting gamesmanship or seeking trade secrecy or producing data-generating patents.[30]

Part II draws on theoretical principles to make two normative claims. First, drawing on the principle of possession, the USPTO should require inventors to disclose the interplay between the input, black box,[31] and output of deep learning inventions to demonstrate dominion and control for enablement and for outside of enumerated abstract idea categories towards for patent eligibility. By viewing deep learning inventions through a possession based lens, it provides *ex ante* state of the art public notice of the use of self-executing AI in the form of deep learning. Second, drawing upon the *Graham v. John Deer Co.* inducement standard,[32] the USPTO should only consider whether the deep learning invention would have been created and disclosed even without patent protection in evaluating non-obviousness of the deep learning invention. The inducement based theory provides that non-obviousness would only cover inventions that recognize patterns in raw data to produce multi-class outputs that would otherwise not be in the public domain. These theoretically driven, normative justifications provide more clear and predictable incentives for patenting of deep learning specifically (and also AI broadly).

Part III draws on these normative justifications to propose prescriptions for patent examination of deep learning inventions. It blends the economizing virtues of possession theory and inducement based theory with the notice function of informal agency actions to recommend a new patent examination framework of deep learning inventions. In so doing, it helps fill a significant gap in the literature, for "the USPTO has been examining AI inventions for decades and has issued guidance in many areas that necessarily relate to AI inventions…further guidance is needed to promote the predictability and reliability of patenting such inventions and to ensure that appropriate patent protection incentives are in place to encourage further innovation in and around this critical area."[33] These prescriptions for patent examination aim to strengthen patent protection of deep learning inventions through more clarity and predictability of enablement, patent eligibility, and non-obviousness.

Part IV explores further implications of this examination proposal through economic theories underlying the patent system. The classical reward, or incentive, theory of patents, suggests that the purpose of patent protection is to strengthen the *ex ante* incentive to invent. The prospect theory suggests that a patent is a type of a prospect that provides exclusive rights to

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[29] Timothy R. Holbrook, Method Patent Exceptionalism, 102 IOWA L. REV. 1001 (2017) at 1010, 1014, 1035.

[30] Brenda M. Simon & Ted Sichelman, *Data-Generating Patents*, 111 NW. L. REV. (2019).

[31] Models of Learning Systems, Encyclopedia of Computer Science and Technology, Vol. 11 (1978).

[32] Michael Abramowicz and John Duffy, The Inducement Standard of Patentability, YALE L. J., Vol. 120 (2010).

[33] Request for Comments on Patenting Artificial Intelligence Inventions, United States Department of Commerce: Patent & Trademark Office, Federal Register, Vol. 84, No. 166 (August 27, 2019).

commercialize and improve new technological resource.[34] This Part offers a key insight for dynamicism and its implications for these patent theories—when physical based doctrines are removed, patent law shifts its emphasis to prospect theory, with only secondary hopes of meeting the goals of reward theory. With dynamicism, the patent theory emphasis is changed to prospect theory.[35] Drawing on contemporary economics of competitive information, specifically the the inverted U-hypothesis theory, this Part concludes that patent breadth of deep learning inventions should be somewhat limited, and in doing so, contributes to a more holistic framework for AI innovation law and policy.

[34] This perspective asserts that strong property rights encourage the rights holder to commercialize the resource in an efficient way without fear that rivals will steal the fruits of the labor. Kitch argued that a sufficiently broad patent grant centralizes the rights to commercialize and improve a patented technology without the fear of competitive appropriation. But unlike the reward theory, the prospect theory focuses on post-grant incentives to develop and improve a patented invention. The focus for the prospect theory is to develop and improve a patented invention, and its view is that a patent that is not commercialized provide no social value beyond its disclosure. Thus, there is an important connection between patent scope and post-grant commercialization with the prospect theory. Prospect theory is characterized by two main attributes—patents should be broad and should be awarded early. The reason for awarding broad patents is to prevent post-grant competition of rivals that would design around the patent to undermine follow-on innovation and development. Furthermore, broad patent grants would give the patentee to make investments without fear of appropriability by competitors. The reason for awarding early patents is to avoid wasteful duplicative efforts in refining the new invention to make it commercially viable. Furthermore, early patent grants allow patent races to proceed beyond preliminary invention and towards commercialization.

[35] There are limitations to the prospect theory perspective. First, prospect theory devotes little attention to the problems that come with monopoly power. Second, the prospect theory assumes a static post-grant activity such that the patentee seeks to maximize the value of the patent in the near term, whereas the patentee may prefer to develop the invention gradually.