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Automation & Predictive Analytics in Patent Prosecution: USPTO Implication & Policy

Tabrez Y. Ebrahim
California Western School of Law, TEbrahim@cwsl.edu

AUTOMATION & PREDICTIVE ANALYTICS IN PATENT PROSECUTION: USPTO IMPLICATIONS & POLICY

Tabrez Y. Ebrahim*

ABSTRACT

Artificial-intelligence technological advancements bring automation and predictive analytics into patent prosecution. The information asymmetry between inventors and patent examiners is expanded by artificial intelligence, which transforms the inventor–examiner interaction to machine–human interactions. In response to automated patent drafting, automated office-action responses, "cloems" (computer-generated word permutations) for defensive patenting, and machine-learning guidance (based on constantly updated patent-prosecution big data), the United States Patent and Trademark Office (USPTO) should reevaluate patent-examination policy from economic, fairness, time, and transparency perspectives. By conceptualizing the inventor–examiner relationship as a "patenting market," economic principles suggest stronger efficiencies if both inventors and the USPTO have better information in an artificial-intelligence-driven market. Based on economics of information and institutional-design perspectives, the USPTO should develop a counteracting artificial-intelligence unit in response to artificial-intelligence proliferation.

* Associate Professor of Law at California Western School of Law and a registered U.S. patent attorney. Thanks to the 4th Annual IP Scholars Roundtable at Texas A&M University School of Law and the Georgia State University Law Review Symposium on legal analytics for providing forums to present this article. The Author especially thanks Professor Thomas D. Barton for his helpful input.

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INTRODUCTION

Recent technological advances in artificial intelligence have introduced automation and predictive analytics to the practice of patent law. Automation tools and the prediction of outcomes will soon be commonplace, reduce costs, and displace some tasks. Legal scholars and practitioners have begun to write about new statistical methods to predict outcomes in patent litigation, and recently, commercial enterprises began selling statistical analysis capabilities to patent litigators. Yet academic research and commercial offerings have ignored the impact of artificial intelligence and machine learning on patent prosecution, which is the negotiation between inventors and the USPTO for exclusive patent rights for a limited time.

Patent prosecution lies, in part, in writing a patent application in a specific manner and understanding the prior art. Analysis and judgment are important skills for any patent attorney or patent agent who represents the inventor and for any patent examiner. But what if patent-application drafting could be automated? What if a data-driven, predictive approach could navigate the vast volume of patent file histories with demonstrably better accuracy, reliability, and speed than humans and basic search tools? This Article addresses these questions. Recent advancements in automation and predictive analytics will soon be commonplace in patent prosecution. Patent scholars and practitioners need to address the technological, legal, and policy issues of artificial intelligence's impact on patent prosecution.

This Article advances the field of legal analytics with a first look into the technology, implications, and policy considerations in patent law specific to the field of patent prosecution. It undertakes an interdisciplinary perspective and is meant for a diverse audience of artificial intelligence and computer science technologists, patent law scholars, practicing patent attorneys and patent agents at law firms, patent counsel who manage patent prosecution in corporations and universities, patent examiners and the USPTO, and patent policymakers. The underlying premise in this Article is that the impact of artificial-intelligence technology on patent prosecution is profound and requires the USPTO to take proactive measures. Unlike past technological advancements in tools for the invention process, artificial-intelligence technology ushers in a form of omniscience in the patent-prosecution process and disintermediates the patent-prosecution process. The move toward automation and predictive analytics in patent prosecution will undoubtedly decrease reliance on patent legal judgment.

In economic terms, artificial-intelligence technology reduces the transaction costs of acquiring patents. One result is that the private sector, which has more resources for artificial-intelligence technologies, will gain an advantage over the USPTO, which is limited in resources and is run with a factory-like mindset. Another result is that in the private sector, parties with easier access to resources for artificial intelligence will gain a competitive advantage in acquiring patents. Therefore, the economic impact of artificial-intelligence technologies will reshape patent law from a policy perspective. The danger in artificial-intelligence technology, particularly predictive analytics that can make predictions from large data sets, is the complex and opaque effects on interactions. Patent-prosecution big data influences behaviors of inventors and patent examiners, and its use during the patent-prosecution process affects the distribution of power.

The behaviors impacted by artificial-intelligence technology can be conceptualized through economic analogies. This Article asserts that artificial-intelligence technology magnifies the information asymmetries between inventors and patent examiners. The concept of information asymmetry was first introduced in economic literature[1] but has been under-studied in patent law scholarship. This Article develops an "economics-of-information" view of how the interaction

1. Lauri Auronen, Asymmetric Information: Theory and Applications 7 (May 21, 2003) (unpublished manuscript), https://pdfs.semanticscholar.org/cdc1/10d48cfa54659f3a09620d51240f09cf1acc.pdf [https://perma.cc/GZ8U-C6GL].

between inventors and patent examiners in a patenting market of inventions will evolve in response to artificial-intelligence technology. It assumes a model where patent examiners make patent-examination decisions of filed patent applications based on information signals that an inventor transmits. After an inventor files a patent application, a patent examiner adjusts his or her conditional probabilistic beliefs of patentability.[2] At some point in the patent-prosecution process, an information-signaling equilibrium is generated; however, artificial-intelligence technology disrupts this information-signaling equilibrium by magnifying the information asymmetry between inventors and patent examiners.[3]

This Article proposes that the magnified asymmetries of information between the inventor and patent examiner in the patenting market be reduced through an intermediary counteracting institution. From an institutional-design perspective, the counteracting institution would best serve as a guarantee of artificial-intelligence-technology-generated inventions and would prevent the reduction of the average quality of inventions created by artificial-intelligence technology. The need for a counteracting institution is based on economic-efficiency views and would impact fairness, time, and transparency policy considerations.[4] A proposed artificial-intelligence-technology-specific counteracting institution may lead some patent law scholars to criticize the USPTO's technology-centric views and to argue that patent law should be technology neutral.[5] Nonetheless, in order to address artificial-intelligence-technology power imbalances in patent prosecution, the USPTO should consider a departure from a technology-neutral view. The economics-based conceptualization of the patenting market between inventors and patent examiners suggests that counteracting artificial-intelligence institutions would allow both inventors and

2. *See infra* Part II.C.1.
3. *See infra* Part II.C.1.
4. *See* Auronen, *supra* note 1, at 9.
5. *See* Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1156 (2002).

patent examiners the same level of information about inventions in a patent-prosecution process that is decreasingly based on human input.[6]

Part I of this Article descriptively introduces the phenomena of artificial intelligence as applied to patent prosecution.[7] Part I further provides an introduction to the practice of patent prosecution and also describes the foundations of automation and predictive analytics in patent prosecution.[8] It provides as examples commercially available automation-software tools for the automation of patent drafting, responses to office actions, and defensive patenting.[9] It describes the use of natural-language processing (NLP) and natural-language generation (NLG) for automation in the patent-prosecution process and the use of machine learning for providing predictive analytics in the patent-prosecution process.[10] It suggests that NLP and NLG can displace some of the art and legal skill of human beings in patent application drafting and that predictive analytics of patent-prosecution big data can displace human judgment in patent prosecution.[11] It presents predictive analytics, which can utilize large and constantly updated patent-prosecution data streams to generate correlations to construct predictive models of particular outcomes based on given conditions.[12] It proposes that machine learning can utilize historical data from patent examination to generate data-driven predictive guidance for revolutionizing the interactions between inventors and patent examiners.[13] The potent combination of predictive analytics and patent-prosecution big data could generate more useful predictive outcomes than patent attorneys, patent agents, or patent analysts who have relied on human-driven hypotheses, elementary models, judgments, hunches, and theories.

6. *See infra* Part II.C.1.
7. *See infra* Part I.
8. *See infra* Parts I.A, I.B.
9. *See infra* Part I.B.1.
10. *See infra* Part I.B.1.
11. *See infra* Part I.C.
12. *See infra* Part I.C.
13. *See infra* Part I.C.

Part II considers implications as a result of the phenomena introduced in Part I through an economics-based conceptualization of the inventor–examiner information exchange.[14] It explores the impact of artificial-intelligence technology on the inventor–examiner information asymmetry with a theoretical-patenting-market economic model analogous to the Spence Model of Information Exchange.[15] It suggests that the combination of automation and predictive analytics in patent prosecution disrupts signaling equilibrium between inventors and patent examiners by increasing the information asymmetry in the inventor–examiner patenting-market exchange.[16] The model's underlying premise is that patent-prosecution big data will undoubtedly accelerate disintermediation of patent prosecution.[17]

Part III analyzes policy and makes a prescriptive claim.[18] It suggests that the private sector's capabilities will soon outpace those of the USPTO and that attaining patent rights will become more affordable to resource-strong private-sector organizations.[19] From a patent policy standpoint, the complexity, speed, and timescales provided by artificial intelligence to patent prosecution have implications for the patent-prosecution profession in various employment settings, for patent examination, for society, and for the USPTO.[20] The damaging consequences increase the existing information asymmetry between inventors and patent examiners.[21] Part III proposes that the advent, adoption, and proliferation of artificial-intelligence technology among inventors and corporations necessitates that the USPTO reevaluate patent policy from economics, fairness, time, and transparency perspectives.[22] Part III proposes a counteracting institution at the USPTO to decrease the

14. *See infra* Part II.
15. *See infra* Part II.A.
16. *See infra* Part II.A.
17. *See infra* Part II.C.
18. *See infra* Part III.
19. *See infra* Part III.B.1.
20. *See infra* Part III.
21. *See infra* Part II.C.4.
22. *See infra* Part III.B.1.

information asymmetries in the inventor–examiner patenting-market exchange that are caused by artificial-intelligence technologies.[23] The final section provides a conclusion.[24]

The Article advances research in legal analytics. It provides the first academic perspective of artificial intelligence specific to patent prosecution with five major points. First, it conceptualizes and parallels the inventor–examiner information exchange during patent prosecution toward the Spence Model of Information Exchange. Second, in applying the Spence Model of Information Exchange, it suggests that automation of patent application drafting and responses to office actions do not affect the conditional probabilities of patent examiners toward patentability. Third, it suggests that predictive analytics and the combination of automation with predictive analytics in patent prosecution impact the conditional probabilities of patent examiners toward patentability. Fourth, it concludes that implementation of artificial-intelligence technology as a prescreening tool in the USPTO is a good first step toward assessing patent applications for patent-examination formalities and for reducing a patent examiner's workload of computer-generated patent applications that overload the USPTO. Fifth, it proposes that the USPTO create a counteracting artificial-intelligence institution that serves as an assessor and as a guarantee of artificial-intelligence-created patent applications and prior art.

I. Artificial Intelligence in Patent Prosecution

The art of being a patent attorney or a patent agent[25] lies, in part, in understanding how to navigate science, technology, and law. In doing

23. *See infra* Part III.C.

24. *See infra* CONCLUSION.

25. U.S. PATENT & TRADEMARK OFFICE, OFFICE OF ENROLLMENT & DISCIPLINE, GENERAL REQUIREMENTS BULLETIN FOR ADMISSION TO THE EXAMINATION FOR REGISTRATION TO PRACTICE IN PATENT CASES BEFORE THE UNITED STATES PATENT AND TRADEMARK OFFICE § 11.6(b) (Oct. 2018) (specifying that any citizen who is not an attorney may be registered as a patent agent to practice before the USPTO); David Hricik, *Patent Agents: The Person You Are*, 20 GEO. J. LEGAL ETHICS 261, 262–63 (2007) (stating that "[p]atent agents are nonlawyers who have passed the patent bar," and although they have not taken three years of legal education, are "equally qualified in the eyes of the [USPTO] to

so, a patent attorney or a patent agent helps inventors translate their inventions concerning the physical world into words and sentences that meet statutory requirements in a patent application and have potential for business value.[26] This translation aspect involves a unique art and technique of crafting a patent application into "patent speak" and involves a methodological and mechanical process of characterizing an invention into a format that is easy to assess by the USPTO.[27] Although some aspects of the patent-application drafting process require the skill of a patent attorney or a patent agent, many aspects can be aided or replaced by artificial-intelligence technology.[28] Similarly, although some analysis and judgment is necessary for a patent attorney or a patent agent to prepare a response to a patent examiner's rejections and objections, many aspects of an office-action response can be automated by artificial-intelligence technology.[29] The practice of patent prosecution conducted by patent practitioners—patent-application drafting and responses to office actions—can be automated for the many aspects that do not require human judgment, hunches, and rules of thumb.[30]

A. The Practice of Patent Prosecution & The Inventor–Examiner Interaction

Patent prosecution can better be described as patent acquisition, which occurs shortly after the time of the invention and determines whether the U.S. government will grant the inventor a patent.[31] The

prosecute patents" and may be better trained than lawyers in communicating with inventors and drafting patent applications due to more recent technical education than a recent law school graduate).

26. Lisa Kennedy, *Patent Agents: Non-Attorneys Representing Inventors Before the Patent Office*, 49 ADVOC. 21, 21 (2006).

27. Leo R. Reynolds, *Intellectual Property Assets*, *in* 1 MASS. CONTINUING LEGAL EDUC., INC. § 4.2 (Lawrence H. Gennari ed., 2005).

28. KAY FIRTH-BUTTERFIELD & YOON CHAE, WORLD ECON. FORUM CTR. FOR THE FOURTH INDUS. REVOLUTION, ARTIFICIAL INTELLIGENCE COLLIDES WITH PATENT LAW 5 (2018), http://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf [https://perma.cc/U4YU-H28E].

29. *Id.*

30. *Id.*

31. Greg Reilly, *Decoupling Patent Law*, 97 B.U. L. REV. 551, 554 (2017).

patent-prosecution process[32] starts with an inventor filing a patent application, which is evaluated by a patent examiner at the USPTO to determine whether the patent application meets the requirements of the Patent Act and thus merits the award of a patent.[33] A patent examiner determines whether the statutory patentability requirements are met before determining whether to issue a patent.[34] Unlike patent litigation, which is adversarial, the acquisition of patent rights has been considered an iterative negotiation of patent rights between a patent examiner and a patent applicant, who typically begins the negotiation process seeking the broadest possible scope.[35]

The art of negotiating with the USPTO to obtain patent protection has been considered to be a rhythmic, structured, and constant clockwork that can be undertaken without much human interaction.[36] Although the patent-application drafting process can involve complexity that meets legal and substantive requirements while telling a story of the inventive concept,[37] much of patent-application

32. Christopher Buccafusco & Jeanne C. Curtis, *The Design Patent Bar: An Occupational Licensing Failure* 2 (Cardozo Legal Studies, Research Paper No. 565, 2018), https://ssrn.com/abstract=3245319 [https://perma.cc/DCD7-E23M] (noting that patent "prosecution" requires that attorneys or agents be members of the USPTO's patent bar, which requires passing the patent bar exam that tests USPTO rules and procedures; suggesting that there are 43,000 registered patent attorneys and agents in the U.S. that can prosecute patent applications, but that the number of actively participating members that prosecute patent applications is likely closer to 25,000); Christi J. Guerrini, *The Decline of the Patent Registration Exam*, 91 NEB. L. REV. 325, 328 (2013) (stating that patent prosecution is unique in that it allows non-lawyers to practice in the field and is the one field of law that conditions entry into the field upon passage of an exam—other than a state bar exam—to ensure that all individuals who practice patent prosecution before the USPTO can competently prepare and prosecute patent applications).

33. CAITLAIN DEVEREAUX LEWIS & KATHRYN B. ARMSTRONG, CONG. RESEARCH SERV., R44962, PATENT LAW: A PRIMER AND OVERVIEW OF EMERGING ISSUES 2 (2017) (summarizing patent prosecution as an administrative process for acquiring a patent from the USPTO).

34. *See* Reilly, *supra* note 31, at 557.

35. Jaron Brunner, *Patent Prosecution as Dispute Resolution: A Negotiation Between Applicant and Examiner*, 2014 J. DISP. RESOL. 7, 7–8 (2014).

36. Carlo Cotrone, *'Patent Prosecutor' or 'IP Counselor'?: Clients and Practitioners Should Choose Wisely*, IPWATCHDOG (Aug. 6, 2017), https://www.ipwatchdog.com/2017/08/06/patent-prosecutor-ip-counselor-choose-wisely/id=86443/ [https://perma.cc/4PAT-BSSV] (suggesting that patent prosecution has negative stereotypes in the legal profession for being formulaic and methodical and not requiring skills from a law degree or legal writing courses; further noting that the measure of success in patent prosecution is for practitioners to get a notice of allowance when instead, the goal should be to provide real-world value to clients' business with counseling guidance).

37. RONALD D. SLUSKY, INVENTION ANALYSIS AND CLAIMING: A PATENT LAWYER'S GUIDE 5–9 (2007) (describing the central theme of patent application as using a problem-solution paradigm to

drafting is standardized and mechanized technical writing.[38] The patent-examination process at the USPTO is a systematic and well-determined workflow, where quality control is emphasized and examiners are allocated fixed amounts of time to complete examination.[39]

B. *Automation Applications in Patent Prosecution*

The practice of patent prosecution, much like other legal practices, is subject to transformation by the rapid rise of artificial-intelligence technologies. The promise of artificial intelligence for law practice lies in the automation of previously manual processes (automation)[40] and in the analytical management process of extracting actionable knowledge from data (predictive analytics).[41] Artificial-intelligence technology, which can learn and adapt in dynamic environments,[42] can draft and review documents or sift through data to predict outcomes in the practice of law generally[43]—and also in the practice of patent prosecution specifically. "LegalTech," which is defined as the use of technology and software to provide legal services,[44] is

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identify the "inventive concept" before drafting patent claims and writing the patent specification).

38. Patrick D. Kelly, *Drafting a Patent Application*, THE BENT TAU BETA PI, Fall 2002, at 17, 17, 19–23, https://www.tbp.org/pubs/Features/F02Kelly.pdf [https://perma.cc/DF8W-XFGB] (indicating that there is standardization to the format of a utility application with the same headings and subheadings, such as: government support, fields of invention, background of the invention, summary of the invention, brief description of the drawings, detailed descriptions, and claims).

39. Iain M. Cockburn, Samuel Kortum & Scott Stern, *Are All Patent Examiners Equal? Examiners, Patent Characteristics, and Litigation Outcomes*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY 19, 23–24 (Wesley M. Cohen & Stephen A. Merrill, eds., 2003) (describing the operation of the USPTO as: being staffed by over 3,000 patent examiners, more than 6,000 total full-time equivalent employees, 235 "Art Units" of examiners in closely related technology areas, over 160,000 patent approvals per year, and generating nearly $1 billion in revenue per year from fees and other revenue streams).

40. *See supra* Part I.B.

41. Jonathan Marciano, *Automating the Law: A Landscape of Legal AI Solutions*, TOPBOTS (June 10, 2017), https://www.topbots.com/automating-the-law-a-landscape-of-legal-a-i-solutions/ [https://perma.cc/ZL6P-E8TQ]; *Patent Services*, TECHPATS, https://www.techpats.com/patent-services/ [https://perma.cc/DZ7M-FFHP] (last visited Feb. 5, 2019); *see infra* Part II.C.

42. Tabrez Y. Ebrahim, *Data-Centric Technologies: Patent and Copyright Doctrinal Disruptions*, 42 NOVA L. REV. (2019).

43. *See* Marciano, *supra* note 41.

44. Eva Hibnick, *What is Legal Tech?*, L. INSIDER BLOG (Sept. 7, 2014) (copy on file with Georgia State University Law Review); Mary Juetten, *The Future of Legal Tech: It's Not as Scary as Lawyers Think*, FORBES (Feb. 19, 2015, 10:00 AM), https://www.forbes.com/sites/maryjuetten/2015/02/19/legal-

disrupting the practice of law[45] and now is disrupting patent-prosecution practice.[46]

1. Automation in Patent Application Drafting & Responses to Office Actions

Technological development has facilitated a trend toward automation in the patent-prosecution profession.[47] To illustrate the pervasive effect, examples can be drawn from different aspects of patent prosecution. For example, there are several ways where the practice of patent prosecution can be impacted by automation.[48] Inventors could use automation technology for preparing the patent application by a patent attorney or a patent agent. Competitors' use of automation tools could impact patent prosecution, such as by automating generation of potential prior art for defensive patenting purposes.

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tech-or-tech-legal/#21a67983257d [https://perma.cc/Q8RL-VZBN]; Basha Rubin, *Is the Legal Tech Boom Over? It Hasn't Even Begun*, FORBES (Aug. 12, 2014, 12:00 PM), https://www.forbes.com/sites/basharubin/2014/08/12/is-legal-tech-boom-over-it-hasnt-even-begun/#26f353864400 [https://perma.cc/ZP85-DL4J]; Basha Rubin, *Legal Tech Startups Have a Short History and a Bright Future*, TECHCRUNCH (Dec. 6, 2014), https://techcrunch.com/2014/12/06/legal-tech-startups-have-a-short-history-and-a-bright-future/ [https://perma.cc/5DVF-HAV9].

45. Catalyst Investors, *LegalTech is Primed for Growth Investments*, ROSS BLOG (Dec. 1, 2017), https://rossintelligence.com/legaltech-growth-investments/ [https://perma.cc/E6BX-AKZP] (describing LegalTech as transforming the legal services industry due to: "[u]nbundling of legal services, thus incentivizing legal firms to earn fees through bespoke services rather than through routine tasks[; i]n-housing of legal work by general counsel[; d]ecreasing number of junior attorneys leading to lower attorney leverage (attorneys per partner) [; i]ncreasing adoption of alternative fee arrangements[; o]utsourcing of legal work to offshore and alternative legal services providers, in turn driving greater transparency and efficiency[; and i]ncremental automation, especially that enabled by AI and big data"); Sarah Garber, *The Third Wave: Why Big Data is the Future of Legal Tech*, IPWATCHDOG (Aug. 9, 2016), https://www.ipwatchdog.com/2016/08/09/big-data-future-legal-tech/id=71675/ [https://perma.cc/L9CU-9ZWM].

46. Joel Nägerl et al., *Artificial Intelligence: A Game Changer for the Patent System*, IAM (Sept. 25, 2018), https://www.iam-media.com/artificial-intelligence-game-changer-patent-system [https://perma.cc/3GGX-PHWZ].

47. *Id.*

48. *Top Five Ways Artificial Intelligence Can Improve Patent Prosecution*, LEXISNEXIS IP (Feb. 2, 2017), https://www.lexisnexisip.com/knowledge-center/top-five-ways-artificial-intelligence-can-improve-patent-prosecution/ [https://perma.cc/SZ3S-3TW4].

LegalTech startups have developed technological solutions for automation of patent-application drafting.[49] Specifio provides automated patent drafting for software-related inventions and can transform a single set of method patent claims developed by a practitioner into a first draft of a patent application within minutes.[50] TurboPatent is a cloud-based tool that automates the patent-application-production and prosecution process via a proprietary AI-powered drafting tool.[51] ANAQUA Studio™ provides patent-drafting tools that reduce drafting time by 50%, analyze patent drafts for statutory requirements, and display identified defects.[52] Inventors have also obtained issued patents directed to automation of

49. *See* SPECIFIO, https://specif.io [https://perma.cc/EY46-LBYC] (last visited Mar. 11, 2019) (mentioning that a patent attorney or patent agent writes a single set of method claims, which serves as the foundation of the auto-generation process that processes the method claims and returns a first draft of patent application in minutes; further stating that an initial three pages of a claim set by a patent practitioner will yield a twenty-five-page first draft by its automated system, and then only requires minimal post-edits, such as adding specific examples or any unclaimed details or any additional figures by the practitioner that are the equivalent of five pages).

50. David Hricik, *Augmented Patent Drafting and Ethics*, PATENTLY-O (June 8, 2017), https://patentlyo.com/hricik/2017/06/augmented-patent-drafting.html [https://perma.cc/G6SR-WKW4]; David Hricik, *Machine Aided Patent Drafting: A Second Look*, PATENTLY-O (Aug. 25, 2017), https://patentlyo.com/hricik/2017/08/machine-patent-drafting.html [https://perma.cc/72PV-B4CE] (summarizing the use of Specifio as requiring five minutes of attorney time to prepare a first draft of a patent application after submitting one patent claim to the automated system, rather than the manual method of fifteen to twenty hours of drafting time); Chelsey Lambert, *Specif.io Review: Automated Patent Drafting for Attorneys and Agents*, LEXTECHREVIEW (May 28, 2018), https://lextechreview.com/specif-io-review-automated-patent-drafting/ [https://perma.cc/G6B8-ELZ6] (clarifying that Specifio's users provide input on the initial part of the patent drafting process and Specifio automates the mechanical writing process, resulting in a complete specification and formal figures within minutes); SPECIFIO, *supra* note 49.

51. *See* Taylor Soper, *This Startup Just Launched Software to Automate Patent Application Process*, GEEKWIRE (Apr. 23, 2015, 9:36 AM), https://www.geekwire.com/2015/for-patent-attorneys-this-startup-just-launched-software-to-automate-patent-application-process [https://perma.cc/N75M-LHPF]; TURBOPATENT, https://turbopatent.com [https://perma.cc/LNG7-FQ6V] (last visited Mar. 11, 2019) (allowing for syncing drawings and invention descriptions, resulting in creating a patent application in less than half of the time that it takes to draft a patent application by hand via incorporating patent drafting best practices, NLP, built-in validations, built-in drawing tools, and customized library of invention drawings; ensuring quality assurance by utilizing semantic search based RoboReview software that uses AI-attorney bots that have been trained by analyzing more than one million patents to help avoid potential errors that could lead to time-consuming office actions).

52. ANAQUA, https://www.anaqua.com/ [https://perma.cc/5E5Q-5EDS] (last visited Mar. 11, 2019) (specifying reduction of the time to produce, prosecute, and process high-quality patent applications by 50% or more, such as saving four hours on drafting of provisional patent applications and saving twenty hours on drafting of nonprovisional patent applications).

patent application such as U.S. Patent No. 8,041,739 titled "Automated System and Method for Patent Drafting and Technology Assessment."[53]

Some may argue that these software-automation tools are another evolutionary step in the progression of technology as a tool to assist an inventor. Inventors have utilized tools to aid in the invention process and patent-prosecution practice for many years.[54] U.S. patent law does not prohibit the use of tools, such as software tools, by inventors.[55] But what extreme capabilities in tools should be regulated? Are there capabilities provided by software tools that dramatically alter the interactions among parties in the patent-prosecution process? Should the principles of economics, fairness, time, and transparency be considered when a new technological capability presents a degree of automation?

Automation tools for patent prosecution, such as for patent-application drafting and responses to office actions, provide drastically greater capabilities to inventors than new tools introduced in the past to the patent-prosecution profession.[56] The more automation is used, the more it will prescribe a sense of mechanization to patent prosecution. Automation tools are exponentially quicker than prior incremental progressions of an inventor's use of a tool, such as a calculator, two-dimensional computer-aid drafting, 3D printing computer-aided design files for rapid prototyping, and finite element-analysis software.[57]

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53. U.S. Patent. No. 8,041,739, at [1] (filed Aug. 31, 2001).

54. *Tools, Materials and Processes*, INVENTORS DIGEST (Sept. 19, 2017), https://www.inventorsdigest.com/articles/tools-materials-processes/ [https://perma.cc/JWS9-6TLX]; Donald Zuhn, *USPTO Adds New Features to PatentsView Tool*, PATENT DOCS (Mar. 5, 2017) https://www.patentdocs.org/tools/ [https://perma.cc/Y23G-LS2B].

55. *See Patent Process Overview*, U.S. PATENT & TRADEMARK OFF., https://www.uspto.gov/patents-getting-started/patent-process-overview [https://perma.cc/APW3-2TT5] (last visited Feb. 5, 2019) (describing the patent application process without mentioning that inventors are restricted in the tools they can use).

56. *See* TURBOPATENT, *supra* note 51.

57. *Automation*, ENCYC. BRITANNICA (last visited Feb. 12, 2019), https://britannica.com/technology/automation/advantages-and-disadvantages-of-automation [https://perma.cc/L4FJ-6TSD].

Unlike prior technological improvements in tools utilized by inventors that minimally and progressively improved the patent-drafting process, automation technologies utilize artificial-intelligence technology that drastically quickens patent drafting to be robot-like automation.[58] For example, Specifio utilizes NLP followed by NLG in a process of text analysis, extraction, synthesis, and text creation.[59] Presumably, Specifio and other patent-drafting automation tools utilize NLP, which allows machines to understand the structure and meaning of language in patent applications.[60] These tools utilize NLP based on finite state automata theory to identify patterns of hierarchical relationships between terms and then match and tag relevant terms for parsing and extraction to assist in automating the patent-application drafting process.[61] The state of the art in NLP can utilize abstract probabilistic models from texts, such as from a database of patent documents, to annotate labels based on guidelines, grammar rules, and statistical data to define when to assign labels.[62] The state of art in NLG can output or write what NLG[63] reads from a database of patent documents and automatically generate a new patent-application draft for review.[64]

58. *Meet Specifio the AI Start-Up Automating Patent Drafting*, ARTIFICIAL LAWYER, (July 28, 2017) https://www.artificiallawyer.com/2017/07/28/meet-specifio-the-ai-start-up-automating-patent-drafting/ [https://perma.cc/ERN9-CFN7] (shedding insight into Specifio's automated patent drafting as utilizing natural language processing and natural language generation to extract all of the important information from the initial patent claim, and then creating a new patent application document from that unstructured data in one automated step, such that 90% of the patent application drafting process is automated, thereby cutting two work-days off the entire patent application drafting process and reducing a twenty-five-hour patent drafting process into at most five hours of patent attorney or patent agent time).

59. *Id.*

60. *Id.*

61. Achille Souili et al., *Natural Language Processing (NLP)—A Solution for Knowledge Extraction from Patent Unstructured Data*, 131 PROCEDIA ENGINEERING 635, 638 (2015) (suggesting that lexico-syntatic patterns in patents serve as structured information, which can be matched for automatic extraction of Inventive Design Method related knowledge from patent documents).

62. Richard Eckart de Castilho et al., *A Legal Perspective on Training Models for Natural Language Processing*, *in* LREC 2018, PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CONFERENCE ON LANGUAGE RESOURCES AND EVALUATION 1267, 1267 (Nicoletta Calzolari et al. eds., 2018).

63. Anna Schena, *What is Natural Language Generation?*, NARRATIVE SCI.: BLOG, https://narrativescience.com/blog/what-is-natural-language-generation [https://perma.cc/Y4LV-N98X] (last modified on Feb. 14, 2019 by Stu Kendall) (characterizing Natural Language Processing as reading while characterizing Natural Language Generation as writing).

64. *TurboPatent Launches AI-Powered RoboReview to Improve Patent Drafting*, TURBOPATENT

Artificial-intelligence automation technologies are being utilized in more than the patent drafting aspect of patent prosecution. Automation technology is being implemented in the negotiation process between the inventor (or the patent attorney or patent agent representing the inventor) and the USPTO to establish the scope of patent rights when a patent is issued.[65] TurboPatent offers an automated-software tool that streamlines responses to office actions, which are response arguments to rejections from patent examiners, that compress a paralegal's time from half an hour to two hours into minutes and save attorney or agent time by displaying the USPTO's office action in an easy-to-read format.[66] Additionally, artificial-intelligence technology provides patent practitioners quicker response arguments to a patent examiner via machine-assisted structuring of amendments[67] to patent claims through comparisons provided by predictive analytics.[68] In other words, strategic insights from historical data[69] can be parsed and evaluated for machine-assisted patent drafting of amendments during the preparation of response arguments.[70] Although these capabilities are not quite at the level of automation (similar to automated patent drafting),[71] artificial-intelligence tools can assist practitioners to more quickly prepare response arguments, and in some cases, provide automated responses

(June 28, 2017), https://www.turbopatent.com/turbopatent-launches-ai-powered-roboreview-to-improve-patent-drafting/ [https://perma.cc/GLN6-SXDW].

65. *See* Brunner, *supra* note 35, at 7.

66. Robert Ambrogi, *New AI-Powered Patent Tool Helps Prepare Responses to Office Actions*, LAWSITES (Feb. 22, 2017), https://www.lawsitesblog.com/2017/02/new-ai-powered-patent-tool-helps-prepare-responses-office-actions.html [https://perma.cc/N337-8678].

67. Tun-Jen Chiang, *Fixing Patent Boundaries*, 108 MICH. L. REV. 523, 526, 529 (2010) (stating that patentees can use ex post claim amendments to change claims during patent prosecution to capture unforeseen developments, and proposing that pre-issuance amendments should not be permitted to capture later developments).

68. *See infra* Part I.C.

69. *See infra* Part III.

70. Stephen Rynkiewicz, *Paralegal Robot Reviews Patent Documents*, ABA J. (July 17, 2017, 2:28 PM), http://www.abajournal.com/news/article/patent_document_robot_legal_review [https://perma.cc/3SW2-566G].

71. *See infra* Part II.B.

in technological areas with commonplace and routine patent examiner rejections, such as business-methods patent claims.[72]

2. *Automation for Defensive Patenting*

Automation-driven technologies assist patent practitioners to generate patent applications for their inventor-clients and corporate clients, but artificial-intelligence automation in patent drafting is also being utilized for defensive patenting.[73]

Cloem is a startup that takes a submitted claim and utilizes its artificial-intelligence technology to create thousands of cloems, or computer-generated permutations of potentially alternative definitions with synonyms, hyponyms,[74] hyperonyms,[75] meronyms,[76] holonyms,[77] and antonyms.[78] Cloem's confidential algorithms utilize best-practices patent-claim drafting techniques with NLP and

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72. *See* Ambrogi, *supra* note 66.

73. Bill Barrett, *Defensive Use of Publications in an Intellectual Property Strategy*, 20 NATURE BIOTECHNOLOGY, Feb. 2002, at 191, 191, https://www.nature.com/articles/nbt0202-191.pdf [https://perma.cc/3MXA-8HH7] (suggesting that, with defensive patenting, in disclosing an invention to the public, the patent applicant has nothing new to disclose to the public because the invention has already been disclosed and therefore is already possessed by the public).

74. LAUREL J. BRINTON, THE STRUCTURE OF MODERN ENGLISH: A LINGUISTIC INTRODUCTION 135 (2000) (defining hyponym as a word or phrase whose semantic field, or a set of words grouped by meaning that refers to a specific subject, is included within that of another word). *See generally* VICTORIA FROMKIN & ROBERT RODMAN, AN INTRODUCTION TO LANGUAGE (Harcourt College Publishers 1998) (1974) (providing as an example that pigeon, crow, eagle, and seagull are all hyponyms of bird, which in turn, is a hyponym of animal).

75. Manfred Stede, *The Hyperonym Problem Revisited: Conceptual and Lexical Hierarchies in Language Generation*, 14 ASS'N COMPUTATIONAL LINGUISTICS 93, 93 (2000) (defining *hypernym* as a more general word than its hyponym). For example, pigeon, crow, eagle, and seagull are all hyponyms of bird, which is their hypernym. *Id.*

76. *Meronymy*, COLLINS ENGLISH DICTIONARY, https://www.collinsdictionary.com/us/dictionary/english/meronymy [https://perma.cc/U4F8-WWV2] (last visited Feb. 18, 2019) (defining *meronymy* as a constituent part of, or a member of something). For example, a finger is a meronym of a hand because finger is a part of a hand. *See id.*

77. Various online dictionaries agree that *holonym* is a term whose whole part is denoted by another term. *See Holonym*, YOURDICTIONARY.COM, https://www.yourdictionary.com/holonym [https://perma.cc/Q8PW-ZEML] (last visited Feb. 25, 2019); *see also Holonym*, VOCABULARY.COM, https://www.vocabulary.com/dictionary/holonym [https://perma.cc/UKN5-SYNX] (last visited Feb. 25, 2019). For example, a body is a holonym of an arm and a leg. *See* VOCABULARY.COM, *supra*; YOURDICTIONARY.COM, *supra*.

78. Dennis Crouch, *Would You Like 10,000 Cloems with That Patent?*, PATENTLY-O (Oct. 1, 2014), https://patentlyo.com/patent/2014/10/would-cloems-patent.html [https://perma.cc/7CKE-U8VX].

undisclosed techniques with 70 million patent documents and proprietary dictionaries to generate combinatorial uses of words.[79] The computer-generated cloems can be published to serve as prior art to prevent competitors from claiming similar and surrounding matters to other patents[80] if enablement is met. This brute-force automation method mechanically composes text for thousands of patent claims that could prevent others from obtaining patent protection in the same field.[81] Many cloems result in nonsense verbiage, but a substantial number could serve as prior art blocking mechanisms when assembled into published applications via this automated mechanism.[82] In effect, Cloem's automation technology serves to generate prior art, which could be an improvement or an adjacent variation invention, to prevent other parties from drafting a patent application and obtaining patent rights on similar subject matter.[83]

C. *Predictive Analytics in Patent Prosecution*

The art of being a good patent prosecutor is more than drafting patent applications and writing responses to office actions. In-house patent counsel and general-counsel clients often hire law firms and attorneys at law firms that will effectively serve as counselors, act as relentless advocates, seek to understand value from the business perspective, and utilize state-of-the-art technologies that guide patent-prosecution strategies in an innovative fashion.[84] Thus, the

79. *Technology*, CLOEM, https://www.cloem.com/flat/technology [https://perma.cc/97X9-JTST] (last visited Feb. 18, 2019) (describing the use of machine creation (e.g., proprietary algorithms, NLP algorithms, semantic technologies, automated reasoning, text mining) and specialized dictionaries (e.g., patent documents, claim construction dictionaries, knowledge base of patent standards, knowledge base of litigated patents, database of millions of technical facts, real-time web and internet-based vocabulary) to generate combinatorial uses (e.g., addition, deletion, insertion, replacement, permutation, interversion, negation, substitution) of any of the following: synonyms (e.g., *computer* and *computing device*); hyponyms (e.g., *mouse* for *input device*); hyperonyms (e.g., *input device* for *mouse*); meronyms (e.g., *button* for *mouse*); holonyms (e.g., *mouse* for *button*); and antonyms (e.g., *close* for *open*)).

80. *See* Crouch, *supra* note 78.

81. Ben Hattenbach & Joshua Glucoft, *Patents in an Era of Infinite Monkeys and Artificial Intelligence*, 19 STAN. TECH. L. REV. 32, 35 (2015).

82. *Id.* at 42.

83. *See* Crouch, *supra* note 78.

84. *See* Cotrone, *supra* note 36 (recommending that a patent prosecutor, as a client–advocate, should

practice of patent prosecution also involves earning a client granted patents with strategically valuable scope—a feat that can more easily be achieved with predictive-analytics technology.

Machine learning, which is a subset of the field of artificial intelligence in computer science, is simply a form of data analysis that uses algorithms to recognize hidden patterns in data without being programmed to do so.[85] Machine learning[86] utilizes algorithms to change its output based on iteratively learning from experiences, and this learning can either be supervised learning or unsupervised learning.[87] Machine learning can classify, categorize, predict, or cluster textual data.[88] The promise of machine learning in the field of patent prosecution is the use of powerful statistical techniques for predicting outcomes in ways that significantly outperform humans.[89] Data-driven, predictive machine-learning-based programs or predictive analytics can predict outcomes better than humans, even the most sophisticated and expert lawyers.[90] A patent attorney or a patent agent who can predict how the USPTO, a particular patent

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utilize evidence-based techniques as a promoter of client value; should periodically raise the value questions during the prosecution of the patent application; and as an innovator, should deliver concrete strategies or solutions based on state-of-the-art technologies).

85. *See* Ebrahim, *supra* note 42 (suggesting that machine learning can produce useful models with predictive capabilities).

86. Harry Surden, *Machine Learning and Law*, 89 WASH. L. REV. 87, 88–89 (2014) (defining machine learning techniques as "algorithms that have the ability to . . . improve in performance over time on some task" by "detect[ing] patterns in data in order to automate complex tasks [and] make predictions").

87. INFO. COMM'R'S OFFICE, BIG DATA, ARTIFICIAL INTELLIGENCE, MACHINE LEARNING AND DATA PROTECTION 7–8 (2017) (quoting Deb Miller Landau, *Artificial Intelligence and Machine Learning: How Computers Learn*, INTEL (Aug. 17, 2016), https://iq.intel.com/artificial-intelligence-and-machine-learning/ [https://perma.cc/8YS8-36YQ]) (defining machine learning generally as being "'the set of techniques and tools that allow computers to "think" by creating mathematical algorithms based on accumulated data'"; specifying that supervised learning involves algorithms based on labelled datasets, such that the algorithms are trained how to map from input to output with the provision of correct values assigned to them, and where the "initial 'training' phase creates models of the world on which predictions can [] be made in [a subsequent] 'prediction' phrase"; and specifying that unsupervised learning involves algorithms that are not trained, but are "left to find regularities in input data without any instructions as to what to look for").

88. Bernhard Waltl et al., *Classifying Legal Norms with Active Machine Learning*, 302 LEGAL KNOWLEDGE & INFO. SYS. 11, 11 (2017).

89. *See id.* at 14.

90. *See id.*

examiner, or a particular art unit would likely prosecute a similar patent application would be a valuable counselor to the inventor-client.[91] Expertise in forecasting outcomes is central to the professional strategic advice of well-regarded patent practitioners.[92] Although human judgment and hunches have been helpful in patent-prosecution counseling, they are often unreliable predictors.[93] In some cases, hunches may represent many years of biases, prejudices, and an outdated understanding of patent-prosecution practice.[94] Experienced patent prosecutors may even be relying on erroneous judgments to counsel clients on patent prosecution.[95]

The use of machine-learning algorithms to analyze and predict from data sets can aid in decision-making.[96] Predictive analytics,[97] which utilizes machine learning,[98] comprises a variety of techniques that predict future outcomes based on historical and current data.[99] The application of predictive analytics to law practice can create more effective risk analysis and can aid sides of a legal interaction or dispute. Predictive analytics can illuminate the root of why certain characteristics among a data set yield certain outcomes to predict future outcomes[100] or provide a new type of information.[101] These

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91. LEONIDAS ARISTODEMOU & FRANK TIETZE, EXPLORING THE FUTURE OF PATENT ANALYTICS 8 (2017).

92. *Id.*

93. Nägerl et al., *supra* note 46.

94. *Id.*

95. *Id.*

96. ARISTODEMOU & TIETZE, *supra* note 91, at 8.

97. JOHN D. KELLEHER ET AL., FUNDAMENTALS OF MACHINE LEARNING FOR PREDICTIVE DATA ANALYTICS: ALGORITHMS, WORKED EXAMPLES, AND CASE STUDIES 1–2 (2015) (defining predictive analytics, or predictive data analytics, as "the art of building and using models that make predictions based on patterns extracted from historical data"; stating that for predictive analytics, a model is trained to make predictions based on a set of historical examples, and that machine learning is utilized to train these models) (emphasis omitted).

98. *Id.* at 3 (defining machine learning as "an automated process that extracts patterns from data" and that these models are used in predictive data analytics to make predictions of new instances).

99. Amir Gandomi & Murtaza Haider, *Beyond the Hype: Big Data Concepts, Methods, and Analytics*, 35 INT'L J. INFO. MGMT. 137, 143 (2015).

100. W.M. Campbell et al., *Predicting and Analyzing Factors in Patent Litigation*, NEURAL INFO. PROCESSING SYS., 2016, at 1, 2, 5–6 (investigating "the root of why certain patents are litigated based on characteristics of the patent" to suggest how to predict which patents will result in litigation; combining posterior probabilities estimated from different features to obtain better prediction performance and to analyze factors in patent litigation; and suggesting the highest weights in litigation

techniques can be applied to patent prosecution where publicly available historical data of each patent application and issued patent provide a variety of textual data[102] that can be aggregated to identify hidden patterns and make strategic predictions.

Data-driven machine-learning techniques that provide predictive analytics of big data impact patent prosecution with a greater magnitude than incremental, prior technological improvements.[103] "Patent-prosecution big data,"[104] which includes historical patent-prosecution data and continuously updated new patent-prosecution data, can outperform traditional statistical techniques in predicting outcomes concerning patent examiners' examination and allowance characteristics.[105] The combination of available historical data[106] and updates of newly issued patents[107] can aid in the production of real-time processing of big-data-patent-prosecution characteristics. [108]

The use of machine-learning technologies in patent prosecution can provide an advantage to competing inventors, to an inventor over the USPTO, or to the USPTO over an inventor.[109] The availability

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prediction).

101. Deven R. Desai, *Exploration and Exploitation: An Essay on (Machine) Learning, Algorithms, and Information Provision*, 47 LOY. U. CHI. L.J. 541, 546 (2015).

102. R. John Milne et al., *ASP, The Art and Science of Practice: How Analytics Practitioners Can Learn from Published Patents and Protect Their Work*, 45 INFORMS J. ON APPLIED ANALYTICS 271, 275–76 (2015).

103. ARISTODEMOU & TIETZE, *supra* note 91, at 8.

104. Gandomi & Haider, *supra* note 99, at 138 (suggesting that a definition of big data is "'high-volume, high-velocity[,] and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making," as well as "'a term that describes large volumes of high velocity, complex[,] and variable data that require advanced techniques and technologies to enable the capture, storage, distribution, management, and analysis of the information") (citations omitted).

105. "Patent-prosecution big data" is the term used throughout this Article to refer to the definition provided and developed by the Author.

106. Alan C. Marco et al., *The USPTO Historical Patent Data Files: Two Centuries of Innovation* 2 (U.S. Patent & Trademark Office, Working Paper No. 2015-1, 2015), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2616724 [https://perma.cc/M7FX-GRNT].

107. *See generally Official Gazette for Patents*, U.S. PATENT & TRADEMARK OFF., https://www.uspto.gov/learning-and-resources/official-gazette/official-gazette-patents [https://perma.cc/HZG3-TW7P] (last visited Feb. 18, 2019).

108. *See* Andrea Giannaccari, *The Big Data Competition Story: Theoretical Approaches and the First Enforcement Cases* 1 (European Univ. Inst. Dep't of Law, Working Paper No. 2018/10, 2018).

109. *See* David Winer, Predicting Bad Patents: Employing Machine Learning to Predict Post-Grant Review Outcomes for US Patents 4 (May 11, 2017) (unpublished masters capstone report, University of

and continuous updating of patent-prosecution data with the USPTO in the public Patent Application Information Retrieval (PAIR) portal[110] repository can serve as a source of data for predictive-analytics applications.[111] As an example, provided below is a patent file history of U.S. Patent 7,405,480[112] that shows data concerning the patent-prosecution process from the time the applicant files it until the USPTO grants it.[113]

California, Berkeley), EECS-2017-60.

110. *Public Patent Application Information Retrieval*, U.S. PATENT & TRADEMARK OFF., https://portal.uspto.gov/pair/PublicPair [https://perma.cc/6QLB-YBUM] (last visited Feb. 19, 2019).

111. Steven Manns & Richard J. Goeke, *A Proposal to Improve Patent Search with Big Data Analytics*, *in* 2017 ANNUAL MEETING OF THE DECISION SCIENCES INSTITUTE PROCEEDINGS 4 (2017), https://pdfs.semanticscholar.org/ccb7/19e1392893fe0c5fa84847e1193cf41282c6.pdf [https://perma.cc/KUY8-AULM].

112. U.S. Patent 7,405,480 (titled "Elimination of Thermal Deformation in Electronic Structures," of which an inventor is Tabrez Y. Ebrahim, the author of this Article).

113. Patent Application Information Retrieval (PAIR) portal file history of U.S. Patent 7,405,480.

11/020,909 — **ELIMINATION OF THERMAL DEFORMATION IN ELECTRONIC STRUCTURES**

Transaction History

Date	Transaction Description
07-29-2008	Recordation of Patent Grant Mailed
07-09-2008	Issue Notification Mailed
07-29-2008	Patent Issue Date Used in PTA Calculation
07-02-2008	Dispatch to FDC
06-25-2008	Application Is Considered Ready for Issue
05-01-2008	Issue Fee Payment Verified
06-23-2008	Mail-Record Petition Decision of Granted to Accept Delayed Payment of Issue Fee
06-23-2008	Record Petition Decision of Granted to Accept Delayed Payment of Issue Fee
06-02-2008	Petition Entered
05-20-2008	Mail Abandonment for Failure to Pay Issue Fee
04-24-2008	Abandonment for Failure to Pay Issue Fee
05-01-2008	Issue Fee Payment Received
01-23-2008	Mail Notice of Allowance
01-22-2008	Notice of Allowance Data Verification Completed
11-16-2007	Date Forwarded to Examiner
11-08-2007	Response after Non-Final Action
08-08-2007	Mail Non-Final Rejection
08-06-2007	Non-Final Rejection
05-21-2007	Date Forwarded to Examiner
05-10-2007	Response to Election / Restriction Filed
04-10-2007	Mail Restriction Requirement
04-02-2007	Restriction/Election Requirement
03-09-2005	Information Disclosure Statement considered
02-13-2007	Case Docketed to Examiner in GAU
01-16-2007	Case Docketed to Examiner in GAU
01-07-2007	Transfer Inquiry to GAU
12-25-2006	Transfer Inquiry to GAU

Figure 1: A representative patent file history from the public Patent Application Information Retrieval (PAIR) portal.

Patent-prosecution big data provides data-driven insights about patent-prosecution strategy. A collection of all of the file histories of issued patents and patent applications is considered patent-prosecution big data, which would constantly be updated as new information is updated and made publicly available. As an example, patent-prosecution big data could assist with providing probabilities and predictions about any of the following: examiner allowance for a particular patent examiner, Notice of Appeal in a particular art unit, relative benefit of an examiner interview, relative benefit for a request for continued examination,[114] average time to allowance, and costs for continued prosecution. This list of possible predictive-analytics insights is vast and open to whatever insights may be desired.

Historically, patent practitioners, patent strategy analysts, and patent-analysis software tools have provided strategic patent-prosecution advice to inventors and clients based on historical data—only descriptive analytics of patent-prosecution data.[115] However, machine learning can allow for building predictive models that react and change with respect to changes in the collective history of patent data with the USPTO—predictive analytics of patent-prosecution data. Thus, unlike descriptive statistics that simply provide analysis of historical data, predictive analytics in patent-prosecution big data would predict with high accuracy what should be expected, so as to allow for strategic, predictive patent prosecution. Predictive analytics in patent prosecution can help to anticipate changes to patent examination based on understanding the patterns and anomalies within patent-prosecution data. A predictive-analytics approach to patent prosecution can anticipate subtle changes in patent examiners' rejections and patent practitioners' response arguments, and as a result, guide responses to office actions by patent practitioners, patent examination by the UPSTO, and patent drafting by patent practitioners.

Predictive analytics, unlike descriptive analytics, can constantly update its models with new patent-prosecution data that reflects changes in patent examination.[116] Because new patent-prosecution data is continually updated by the USPTO and made available to the

114. U.S. PATENT & TRADEMARK OFFICE, MPEP § 706.07(h) (9th ed., Rev. Jan. 2018) (quoting 37 C.F.R. § 1.114(a) (2015)) (defining Request for Continued Examination Practice and stating that even "'[i]f prosecution in an application is closed, an applicant may request continued examination of the application by filing a submission'" and paying additional fees) [hereinafter MPEP].

115. *Increase Your Patent Prosecution Efficiency with Comprehensive Patent Analytics*, LEXISNEXIS IP, https://www.lexisnexisip.com/products/patent-advisor/ [https://perma.cc/58BC-GHFQ] (last visited Feb. 19, 2019).

116. Mark van Rijmenam, *The Future of Big Data? Three Use Cases of Prescriptive Analytics*, DATAFLOQ (Dec. 29, 2014), https://datafloq.com/read/future-big-data-use-cases-prescriptive-analytics/668 [https://perma.cc/MV3G-5DFN].

public, predictive analytics would change and adjust to new information. Thus, patent practitioners can analyze a patent examiner's patent-prosecution history to predict how that particular patent examiner (or that art unit)[117] will treat future patent applications in that art unit.[118] For example, patent practitioners can use predictive analytics to analyze patent-examiner allowance rates, art-unit allowance rates, and the average number of office actions before allowance.[119] These capabilities can inform the development of patent-prosecution strategies and the best course of action in a pending patent application, such as an optimal time to schedule an examiner interview,[120] an optimal time to abandon[121] a patent application, and when to pay additional fees for a request for continued examination.[122] These insights can have a number of strategic advantages for patent practitioners, which can reduce the number of office actions they receive for their clients from the USPTO, and in turn, reduce costs for their clients.[123] Patent practitioners can use these predictive-analytics capabilities to determine the likelihood of patent issuance at early stages of the patent-prosecution process, and in turn, better allocate time and money resources for their inventor clients.[124]

117. *See Patent Classification: Classes Arranged by Art Unit*, U.S. PATENT & TRADEMARK OFF., https://www.uspto.gov/patents-application-process/patent-search/understanding-patent-classifications/patent-classification [https://perma.cc/4CH8-BPUW] (last visited Feb. 19, 2019).

118. *How Predictive Analytics Is Reshaping Patent Prosecution*, LEXISNEXIS IP (June 2, 2016), https://www.lexisnexisip.com/knowledge-center/how-predictive-analytics-is-reshaping-patent-prosecution/ [https://perma.cc/RSK4-DDHE].

119. *Id.*

120. MPEP, *supra* note 114, § 713 (stating that "[a]n [examiner] interview [may] be granted when the nature of the case is such that the interview serves to develop or clarify outstanding issues in an application"; specifying that discussions between a patent applicant and a patent examiner can advance the prosecution of a patent application and improve the mutual understanding of specific issues concerning the substantive matters at issue in an application).

121. *Id.* § 711 (stating an abandonment of a patent application can be based on a failure to timely reply, a lack of a bona fide attempt to advance the prosecution of the patent application, or an express abandonment).

122. *Id.* § 706.07 (specifying the conditions and required fees that enable the continued examination of patent applications at the request of the patent applicant).

123. LEXISNEXIS IP, *supra* note 118.

124. *Id.*

A predictive-analytics approach can also guide automated patent drafting and automated responses to office actions from the USPTO.[125] A patent practitioner that has enough good data about patent examination beforehand can draft a patent application based on analyzing the constantly updating patent-prosecution data that reflects changes in patent examination.[126] With enough good and predictive data, a patent practitioner can determine relationships between types of words in patent claims that will lead to fewer office actions and quicker allowance. In other words, predictive analytics can identify variables that greatly influence a patent examiner's evaluation decision and how those variables interact with each other to help guide the patent-drafting process.[127] Although a human would not be able to properly assign weights to numerous variables and understand how different variables interact with each other, predictive analytics can determine the hidden connection between variables.[128] Neither humans nor standard regression techniques would be able to evaluate multitudinous variables concerning patent-prosecution data, nor would they be able to constantly update relationships between variables with constantly changing patent-prosecution data.[129] Predictive analytics of patent-prosecution data would draw distinctions between examiner rejections and can help patent practitioners compare previously allowed similar technology area patent claims to guide in drafting the structure and language of the current patent application.[130]

In sum, algorithmic predictions from predictive analytics can displace human judgment or can provide analytical support to human judgment in responses to office actions and to drafting of patent

125. *See supra* Part I.B.1.
126. LEXISNEXIS IP, *supra* note 118.
127. *Id.*
128. Daniel Gutierrez, *Classes of Predictive Analytics*, INSIDE BIG DATA (Sept. 18, 2014), https://insidebigdata.com/2014/09/18/classes-predictive-analytics/ [https://perma.cc/S82Q-BG4S].
129. *See* LEXISNEXIS IP, *supra* note 118.
130. Sarah Garber, *Avoiding Alice Rejections with Predictive Analytics*, IPWATCHDOG (May 31, 2016), https://www.ipwatchdog.com/2016/05/31/avoiding-alice-rejections-predictive-analytics/id=69519/ [https://perma.cc/E89B-S7EU].

applications. This is not to say that predictive-analytics tools are perfect. The machine-driven algorithms can only deal with the patent data that is available.[131] But predictive analytics can provide a super-human assistance tool that can help patent practitioners in a number of ways—better decision-making and more confidence in responses to office actions and to drafting of patent applications.

II. Implications to the Inventor–Examiner Information Exchange

The advent of artificial-intelligence technologies can have undesirable consequences, which can be assessed from an economics-of-information and institutional-design perspectives. The impact of artificial-intelligence technology on the USPTO and patent prosecution can be analyzed with a theoretical-economics lens, which conceptualizes the inventor–examiner with a market perspective.[132]

A. Inventor–Examiner Information Asymmetry & the "Patenting Market"

The concept of information asymmetry in the field of economics is defined as when one party to a transaction knows more than the other party about the deal underway.[133] In many cases, information asymmetry is not desirable, such as in an interview setting where the potential employer would want to know as much about the potential employee (interviewee) for a hiring decision and signals to the employee to reveal information, and the potential employee signals to

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131. *See* LEXISNEXIS IP, *supra* note 118.

132. *See infra* Parts II.A–C.

133. Richard Holden, *Economic Theories That Have Changed Us: Asymmetric Information*, CONVERSATION (June 21, 2015, 4:19 PM), http://theconversation.com/economic-theories-that-have-changed-us-asymmetric-information-42120 [https://perma.cc/C4D3-J8NU] (stating that where one party to a potential transaction is better informed than the other party, it can lead markets to fall apart completely; suggesting that in a hypothetical market with two types of sellers—good types that have good quality cars, and bad types that have bad quality cars—will result in "adverse selection" where the market is comprised solely of bad type participants; and noting that an informed party can improve its outcome by "signaling," or telling or showing buyers that her product is of good quality, and that an uniformed party can improve her outcomes through "screening," or sifting through clues to determine quality).

the potential employer qualifications.[134] The interaction between inventors and patent examiners also has information symmetry because the inventor has more information about the invention than the USPTO, and the inventor to reveals information about the invention.[135] The negotiation between an examiner and an inventor can be conceptualized as a set of interactions that is similar in some ways to the interviewee–employer context. The USPTO's administration of patent prosecution can be conceptualized as a market, where the inventor is a seller of a good (an invention) and the patent examiner is a buyer of the invention.

The theory of asymmetric information and its impact on markets suggests that its undesirable consequences are moral hazard, monopoly of information, and adverse selection.[136] Asymmetric-information theory suggests that the inventor and patent examiner interaction would have similar negative consequences, which would result in less-than-optimal grants of patents by the USPTO and be a detriment to the USPTO's resources.[137] Moreover, a common feature of market interactions is that buyers and sellers in a market possess different information, which affects their behavior in many situations and gives rise to a number of questions.[138] Thus, a market where inventors and patent examiners possess different information, such as where technology skews information about an invention toward one side, would affect behaviors of the parties. Artificial-intelligence technology skews the information about an invention further toward the inventors with a current, resource-

134. Tshilidzi Marwala & Evan Hurwitz, Artificial Intelligence and Asymmetric Information Theory (Oct. 14, 2015) (unpublished manuscript) (on file with Cornell University Library), https://arxiv.org/ftp/arxiv/papers/1510/1510.02867.pdf [https://perma.cc/2V2E-DDD5].

135. *Id.*

136. *Id.*

137. *Id.*

138. Karl-Gustaf Löfgren et al., *Markets with Asymmetric Information: The Contributions of George Akerlof, Michael Spence and Joseph Stiglitz*, 104 SCANDINAVIAN J. ECON. 195, 196 (2002) (suggesting that information asymmetries give rise to the following questions: "What happens to prices, traded quantities and the quality of traded goods, if agents on one side of the market are better informed than those on the other? What can better-informed agents do to improve their individual market outcome? What can less-informed agents do?").

limited USPTO. As a proposed solution,[139] the asymmetry of information between parties in a market can be reduced through a counteracting institution, or an intermediary market institution,[140] which can be created and housed within or outside of the USPTO.

The patent-prosecution interaction[141] can be conceptualized as a "patenting market," which is defined as inventors being sellers of inventions and the USPTO being buyers of inventions. In this inventions-as-goods marketplace, patent prosecution is characterized by significant information asymmetry between inventors and patent examiners at the USPTO.[142] The inventor–examiner information asymmetry is based on information relating to the prior art that is most likely known to the inventor.[143] The inventor knows more about his or her invention than a patent examiner who will be new to learning about the invention upon the start of the patent-examination process.[144] Moreover, the inventor is also in a stronger position to argue against a patent examiner in response arguments to USPTO rejections with patent-claim amendments.[145] More specifically, an inventor can utilize a greater or lesser scope of the invention through claim amendments later in patent prosecution and, in doing so, catch the patent examiner by surprise and require the patent examiner to reassess patent claims that may be enlarged or restricted via amendments.[146] Thus, the current distribution of power between the

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139. *See infra* Part III.C.

140. Auronen, *supra* note 1, at 9 (suggesting that guarantees of goods would allow the buyer sufficient time to reach the same level of information about the good).

141. *See supra* Part II.A.

142. Jay P. Kesan, *Carrots and Sticks to Create a Better Patent System*, 17 BERKELEY TECH. L.J. 763, 767 (2002).

143. *Id.* (suggesting that the USPTO is unlikely to be informed about relevant prior art because patent examiners may not be aware of where to discover relevant prior art beyond traditional patent databases).

144. *Id.*

145. *See* Chiang, *supra* note 67, at 531–34 (stating that the patentee can amend patent claims with broad freedom during pre-issuance amendments and can also change the patent claims through complex procedures is a post-issuance amendment).

146. *Id.* As stated in the Manual of Patent Examining Procedure and as is known in patent-prosecution practice, no new matter can be introduced through claim amendments and only material found in the four corners of the patent application at the time of filing can later be utilized in claim amendments. MPEP, *supra* note 114, § 714. Even under these restrictions, an amendment later in prosecution may give the patent examiner more (or less) to consider about the invention, and in doing

inventor and the USPTO is skewed toward the inventor knowing more about the invention in a patenting market of inventions.

B. Assumptions of the Inventor–Examiner Information Asymmetry

Inventors' capabilities outstrip the USPTO even further with the advent of artificial-intelligence technologies. The emergence of artificial-intelligence technologies, particularly automation and predictive analytics, expands the information asymmetries between inventors and patent examiners.[147] Artificial-intelligence technology allows inventors to have more information than the patent examiner about the invention due to: (1) differences in financial resources; (2) differing conditions and mindsets that drive behaviors during the patent-examination interaction; and (3) the presumption of patentability and burdens during patent examination.[148]

First, because the USPTO is an administrative agency with limited financial resources, inventors have more resources than patent examiners, allowing inventors to know even more about the invention.[149] The USPTO is a business that operates largely from fees generated from patent filings, patent prosecution, and maintenance payments.[150] The USPTO is a fully fee-funded agency dependent on appropriations, yet it operates with standard private-sector practices and is subject to economic recessions.[151] These structural

so, the patent examiner would need to reevaluate the patent claims based on the amendments and the response arguments to a non-final office action. *Id.* Thus, an inventor will continue to know more about his or her invention even if patent examiner makes a non-final rejection because an inventor can amend claims. *Id.* However, during a final rejection (as mentioned in the MPEP in § 714 and in 37 C.F.R. § 1.116), the inventor may only amend a claim to cancel it or to put it in compliance with any requirement previously set forth in a previous Office Action, unless the inventor provides good and sufficient reasons as to why the amendment was necessary and not earlier presented. *Id.*

147. *See* LEXISNEXIS IP, *supra* note 118.

148. *See supra* Part II.B.

149. U.S. PATENT & TRADEMARK OFFICE, FISCAL YEAR 2018 CONGRESSIONAL JUSTIFICATION 27 (May 23, 2017), https://www.uspto.gov/sites/default/files/documents/fy18pbr.pdf [https://perma.cc/E52W-7PWT].

150. *Budget and Financial Information*, U.S. PATENT & TRADEMARK OFF., https://www.uspto.gov/about-us/performance-and-planning/budget-and-financial-information [https://perma.cc/Y4VX-ZHRH] (last visited Feb. 19, 2019).

151. U.S. PATENT & TRADEMARK OFFICE, *supra* note 149, at 7.

characteristics create a USPTO environment and operation with minimal resources for understanding inventions in-depth. Moreover, the USPTO is subject to budget adjustments based on the U.S. President's determination[152] and political budget cuts.[153] The USPTO cannot raise funds from outside organizations and investors, whereas private-sector groups can access artificial-intelligence technology more easily with more available financial resources.[154] Even in the case when private-sector groups have limited financial resources, they can seek internal funding from corporations' boards of directors and external funding from banks, angel investors, and venture capital groups to support the development and use of artificial-intelligence tools.[155] Thus, the financial disparity between the private sector and the USPTO creates differences in relative resources available and for use toward gaining in-depth knowledge of inventions.

Second, inventors and patent examiners have different conditions and mindsets that drive their behaviors during patent examination and influence whether they can or want to access artificial-intelligence technologies.[156] These conditions lessen the need for artificial-intelligence technologies within the USPTO and, therefore, lessen the need to utilize artificial-intelligence tools to understand

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152. Dennis Crouch, *Trump's Budget Proposal for USPTO Flat for FY 2019*, PATENTLY-O (Feb. 13, 2018), https://patentlyo.com/patent/2018/02/trumps-budget-proposal.html [https://perma.cc/H82F-ERLT] (stating that the proposed USPTO budget would allow the USPTO to spend up to $3.459 billion in 2019).

153. Department of Defense and Full-Year Continuing Appropriations Act, Pub. L. No. 112-10, § 1329, 125 Stat. 38, 121 (2011) (cutting $100 million from the USPTO budget and postponing indefinitely the Fast Track program, which was designed to help expedite the processing of patents through an added fee).

154. Melissa Horton, *Types of Funding Options Available to Private Companies*, INVESTOPEDIA (Jan. 15, 2019), https://www.investopedia.com/ask/answers/062315/what-type-funding-options-are-available-private-company.asp [https://DYT9-BEGV]; *USPTO Funding*, INTELLECTUAL PROP. OWNERS ASS'N, https://www.ipo.org/index.php/advocacy/hot-topics/uspto-funding/ [https://perma.cc/3VM7-V32N] (last visited Feb. 27, 2019).

155. Horton, *supra* note 154.

156. *See* Naira Rezende Simmons, *Putting Yourself in the Shoes of a Patent Examiner: Overview of the United States Patent and Trademark Office (USPTO) Patent Examiner Production (Count) System*, 17 J. MARSHALL REV. INTELL. PROP. L. 33, 41 (2017) (describing the system in which a patent examiner works "with the explicit goal of helping a patent applicant understand the system in which a Patent Examiner operates").

inventions.[157] Patent examiners are expected to be efficient in assessing patentability with a limited amount of time and with productivity assessments relative to production units.[158] It is well known in patent practice that patent examiners are overloaded with information and face difficulties in efficient and effective use of time to sort through information.[159] Patent examiners are faced with a backlog of patent applications and are limited to the number of patent claims they can examine in a patent application.[160] Patent examiners' tasks are lengthy and complicated since examiners must read and understand the entire patent-application document, search for prior art references, and analyze and compare the patent application to the prior art.[161] The factory-like conditions and the presence of the "count" system[162] necessitate that patent examiners work quickly and efficiently.[163] The mindset of a patent examiner is to advance patent prosecution, which can often be conducted in a cursory fashion to satisfy production units relative to the patent examiner's production goal.[164] These conditions and mindsets in patent prosecution may seem to suggest that artificial-intelligence technology would aid in patent examination behaviors and practice. However, paradoxically, although artificial-intelligence technology would make that patent examiner's job easier, it would also reduce the need for the USPTO

157. *Id.*

158. *Id.* at 33–34 (describing that a patent examiner's tasks include "reading and understanding patent specifications, searching the prior art to determine what technological contribution the application teaches the public, and evaluating the scope of the claims" and that "[u]nder the current production system, productivity is assessed based on Production Units ('PUs') achieved relative to the Examiner's production goal[,] . . . [which] is calculated . . . based on the number of 'Examining Hours'" and on different "counts" for different tasks performed in different stages of patent prosecution).

159. Jeffrey M. Kuhn, *Information Overload at the U.S. Patent and Trademark Office: Reframing the Duty of Disclosure in Patent Law as a Search and Filter Problem*, 13 YALE J.L. & TECH. 90, 95 (2010).

160. Ayal Sharon & Yifan Liu, *Improving Patent Examination Efficiency and Quality: An Operations Research Analysis of the USPTO, Using Queuing Theory*, 17 FED. CIR. B.J. 133, 162 (2008).

161. *See* Simmons, *supra* note 156, at 33–34 (suggesting a proper review of a patent application necessitates learning a new technology in some aspects or perhaps entirely, and this in-depth review is complicated further by increased technological complexity, the exponential growth of available prior art, and changes in policy and interpretation in patent law in recent years).

162. *Id.* at 34–38.

163. *Id*. (providing details of the "count" system, which quantifies Production Units for different tasks performed in different stages in patent prosecution and which affects advancement and promotion).

164. *Id.* at 37.

to employ patent examiners. Thus, the conditions and mindset of patent examiners promote meeting the requirement of the count system and thereby reducing the need for artificial-intelligence technology. In fact, implementing any artificial-intelligence technology would disrupt the count system and require the development and implementation of a new production system. Adoption of artificial-intelligence technology by patent examiners and USPTO administration would lead to resistance from the professional union of U.S. patent examiners, the Patent Office Professionals Association (POPA).[165] Also, artificial-intelligence-technology vendors would be less prone to sell artificial-intelligence systems to the USPTO compared to private-sector enterprises that are not encumbered by a count system in their operations. These conditions suggest that patent examiners would have a lower desire than inventors to embrace artificial-intelligence technology. In turn, patent examiners would be less prone to gain in-depth knowledge of inventions even with available artificial-intelligence technology.

Third, the presumption of patentability and burdens during patent examination make artificial-intelligence technology less necessary for patent examiners than for inventors. A patent application is rebuttably presumed to meet patentability at the time of filing.[166] Accordingly, there is a presumption that an adequate written description of the claimed invention is present at the time of filing a patent application, and thus, the patent examiner has the initial burden of presenting evidence and reasons why a person skilled in the art would not recognize the written description of the invention as providing adequate support.[167] The initial examination of a patent application requires the patent examiner to construe the patent

165. PAT. OFF. PROFS. ASS'N, http://www.popa.org/ [https://perma.cc/GQ2T-TZVE] (last visited May 31, 2019).

166. Sean B. Seymore, *The Presumption of Patentability*, 97 MINN. L. REV. 990, 995 (2013) (explaining that a patent application enjoys the presumption of patentability at the time of filing because "the patent application is rebuttably presumed to comply with the utility, novelty, nonobviousness, and disclosure requirements of the patent statute").

167. MPEP, *supra* note 120, § 2163 (stating that the initial burden, after a thorough reading and evaluation of the context of the patent application, is with the patent examiner).

claims, and the patent examiner has the initial burden to establish a reasonable basis to make a rejection.[168] The presumption of patentability for the inventor and the initial burden on the patent examiner suggest that the use of artificial-intelligence technology by an inventor helps strengthen the inventor's position more than use by a patent examiner. Artificial-intelligence technology magnifies the presumption of patentability by providing strategic patenting techniques, thereby making it more burdensome for the patent examiner to develop rejections.[169] Thus, artificial-intelligence technology gives an inventor greater offensive capability, which necessitates even more defensive effort from the patent examiner.

In sum, the emergence of artificial-intelligence technologies magnifies the information asymmetries between inventors and patent examiners. Artificial-intelligence technology is more accessible, applicable, and necessary for inventors than patent examiners. Therefore, artificial-intelligence technologies allow inventors to have even more information than patent examiners.

C. Patenting Market Signaling with Artificial-Intelligence Technology

The information asymmetry between inventors and patent examiners is based on inventors having more information about their inventions than patent examiners.[170] Artificial-intelligence technology distorts this patenting market, or the institution whereby inventors and the USPTO engage in exchange.[171] The relationship and exchange between inventors and patent examiners, and the efficiency in this exchange, are impacted by artificial-intelligence technology.

One study suggests that the degree of asymmetry of information between two artificial-intelligence agents is less than that between

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168. *Id.* § 2164.04 (stating that the patent examiner has the initial burden to question the enablement provided for the claimed invention).

169. Seymore, *supra* note 166, at 995–96.

170. Kesan, *supra* note 142, at 767.

171. Marwala & Hurwitz, *supra* note 134.

two human agents.[172] Accordingly, a patenting market where inventors and patent examiners have access to and utilize artificial-intelligence technology would decrease the underlying information asymmetry. Thus, when both sides of the patent-prosecution exchange have equal use of artificial-intelligence technology, there is a market-efficiency gain. This study reasons that two artificial-intelligence agents in a marketplace would result in a lower volume of trades and increase the market efficiency as the market becomes saturated with intelligent trading and analysis agents.[173] Economic principles suggest that these efficiency gains would result in falling prices and better allocation of patenting resources in comparison to a marketplace where one party in the patenting market has more information about the invention and more artificial-intelligence capabilities than the other party.[174]

However, the case of a marketplace with one side being an artificial-intelligence agent and another side being a human being has been under-studied. Although one can surmise that there would be an effect on market efficiency with one-sided access and use of artificial-intelligence technology, the degree of impact on the market would depend on the artificial-intelligence technology's ability to complement or displace human decision-making. The degree of signaling by the party possessing and implementing the artificial-intelligence technology would affect the market efficiency and the possibility of resolving the asymmetry of information. A

172. *Id.*

173. *Id.* Marwala and Hurwitz further state:

> If a market is full of agents such as the artificially intelligent agents A and B then the market will have agents where information is more symmetrical and therefore it will be more rational. Moreover, these artificially intelligent agents will be [better] able to analyze all the data at their disposal, estimate latent information and process all the information at their disposal than a human being. Thus the decisions of the artificially intelligent agents will be less rationally bounded than the decisions of the human agents. Therefore, the deployment of artificial intelligent agents make [sic] information in the markets more symmetrical (or less asymmetrical) and this in turn makes the markets more efficient.

Id.

174. *Id.*

signaling equilibrium would reduce information asymmetry between the buyer and seller parties in a market exchange.[175]

Michael Spence studied signaling in markets with asymmetric information in his 1973 seminal paper *Job Market Signaling*, which models the hiring of employees as investment decisions under uncertainty and where the employer is not certain of the interviewee's capabilities during a hiring decision.[176] The example below depicts an application of Spence's *Job Market Signaling* model toward the patenting market, analogizing an employer with a patent examiner and analogizing an interviewee with an inventor.[177] In Spence's model, potential employees send a signal about their capabilities to an employer by acquiring educational credentials, and the information value of the potential employee's educational credentials comes from the potential employee's belief that educational credentials should enable the employer to distinguish that potential employee as a high-ability worker from other lower-ability workers.[178] Thus, Spence's signaling refers to observed knowledge gaps between potential employees and an employer organization that gives rise to difficulty in the employer organization with detecting of a desirable intangible trait of the credential (Spencian signaling).[179] The signal in Spence's model refers to the potential employee revealing information to an employer, such that the employer updates prior conditional probabilities and has a willingness to employ an employee with better educational credentials, and the two parties overcome asymmetries to reach an equilibrium.[180]

Unlike Spencian signaling, the initial signaling in current USPTO patent examination from a patent applicant and the USPTO is informational signaling. In other words, Spencian signaling would not apply to current USPTO patent examination, because the

175. *See* Auronen, *supra* note 1, at 11–12.
176. Michael Spence, *Job Market Signaling*, 87 Q. J. ECON. 355, 356 (1973).
177. *See infra* Parts II.C.1–4.
178. Spence, *supra* note 176.
179. Id.
180. *Id.*

signaling by an inventor to the USPTO does not assume a difference to be a desirable attribute between applicants. An inventor does not signal to the USPTO a difference or a desirable trait of its invention in comparison to other inventions but instead provides an information signal to the USPTO. However, as this Article later asserts, the underlying model of Spencian signaling would apply to a world that increasingly comprises a mix of inventors possessing artificial-intelligence capabilities and investors lacking those capabilities to signal a desirable attribute of invention without artificial-intelligence technologies (Artificial Intelligence Spencian Signaling).[181]

In contrast to Spencian signaling, information signaling refers to providing information about one party to another party. Thus, similar to how an employer is not certain of an interviewee's capabilities before a hiring decision, a patent examiner is not certain of the capabilities of an invention before granting a patent for the inventor's patent application in the information-signaling context. Thus, the example below parallels an employee–employer interview interaction with an inventor–examiner interaction for the phenomena of information signaling in reducing information asymmetry.[182] It adds to the conceptualization by considering the effects of artificial-intelligence technology toward signaling and its effect on asymmetric information.

1. General Information Feedback in the Patenting Market

The model of information feedback in the patenting market relates to a series of iterations between the inventor and the patent examiner.[183] The description presented herein parallels an analysis of the Spence Model of Information Exchange[184] but is distinguished as being a type of information signaling and is depicted in Figure 2

181. *See supra* Part III.C.
182. *See infra* Parts II.C.1–4.
183. *See infra* Figure 2.
184. *See* Spence, *supra* note 176, at 360; Auronen, *supra* note 1, at 11–12.

below.[185] First, the inventor decides on its information signaling based on maximization of patent scope return net of signaling costs. Second, the patent examiner conducts an initial examination of the patent application after the first filing.[186] Thus, in this parallel analysis, hiring in the Spence Model Information Exchange is akin to a patent application clearing formalities upon reaching the USPTO. Third, the patent examiner observes the patent claim scope as filed and adjusts his or her conditional beliefs based on the patentability at each stage of patent prosecution.[187] This third stage is based on the signals and indices indicated by the inventor with the initially filed patent claims and concerns the patent examiner's conditional beliefs with examination of patent claims. Thus, an inventor who files overly broad patent claims will signal different observable attributes of the invention than an inventor who files a relatively broad set of patent claims. Just as the signals and indices of the interviewee are regarded as shifting probability distributions that define an employer's beliefs in the Spence Model Information Exchange,[188] the signals and indices of an inventor shift the probability distribution that defines a patent examiner's beliefs. Fourth, the patent examiner presents a new interpretation with an offered patent claim scope as a function of signals and indices in response to the patent examiner's adjusted conditional beliefs.[189] Here, the patent examiner presents a new patent claim scope as a function of the signals and indices with rejections in office actions. The iteration is repeated, and equilibrium

185. *See infra* Figure 2.

186. Note that although Figure 2 shows in (2) "Examine *Initial* Patent Application," there will be *subsequent* examinations of the patent application with responses to office actions from the inventor following each rejection from the patent examiner. Thus, the loop diagram is iterative, and the label box (2) can also be represented with language indicating "Examine Patent Application." However, the word "*Initial*" is utilized to follow the Spence Model of Information Exchange by analogy and to demonstrate that there must still be a first examination conducted before a patent examiner adjust conditional probabilistic beliefs.

187. *See infra* Figure 2.

188. Spence, *supra* note 176, at 359–60.

189. *See infra* Figure 2.

is reached when the conditional beliefs are confirmed by the informational signaling they generate.[190]

Information Feedback in the "Patenting Market"

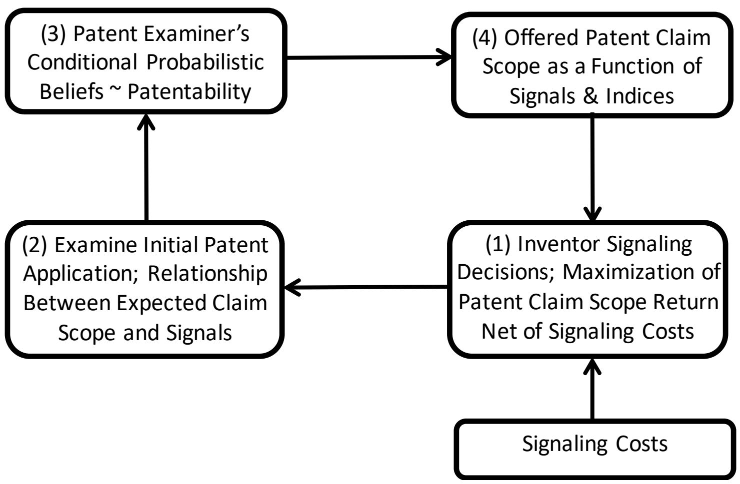

Figure 2: Information Feedback in the Patenting Market

In the Spence Model of Information Exchange, the employer's conditional probabilistic beliefs are modified in response to repeated cycles around the loop as successive waves of new applicants come into the market.[191] By analogy, successive waves of new applicants in the Spence Model of Information Exchange equates to successive waves of responses by a patent applicant to patentability rejections by a patent examiner via office actions to the inventor.[192] Thus, as applied to the patenting market, Figure 2 demonstrates repeated cycles around a loop that can be based on a sequence of responses to office actions and a possible continuation of patent prosecution beyond a final rejection through one or more requests for continued

190. *See* Auronen, *supra* note 1, at 11.
191. Spence, *supra* note 176, at 360.
192. *See id.*

examination.[193] The patent-prosecution process is an iterative process of rejections and responses to office actions, such that an equilibrium is reached when the patent examiner's conditional beliefs are confirmed by the signals that an inventor generates.[194] For example, an inventor who either amends patent claims to narrow their scope or makes new legal arguments in response to an office action would lessen the probability of a subsequent rejection by a patent examiner for a patentability criterion.[195] The introduction of automation modifies this model of information feedback in the patenting market as shown in Figure 3 below.[196]

2. "Patenting Market" with Automation

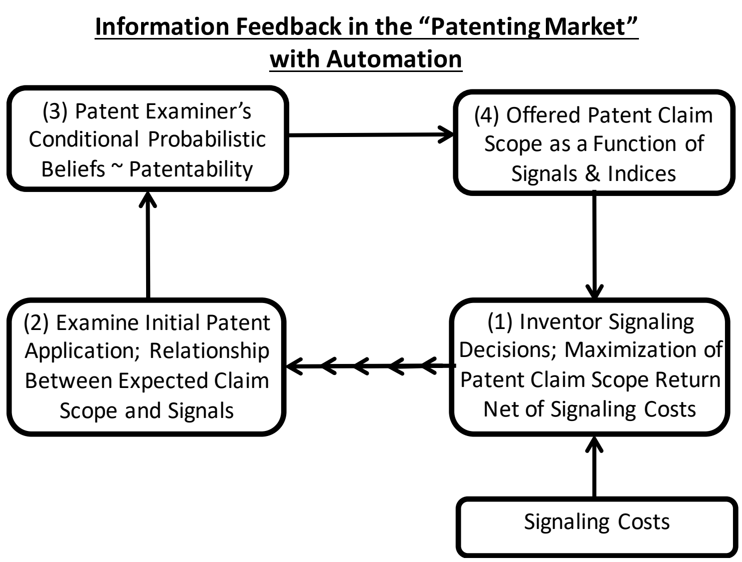

Figure 3: Information Feedback in the "Patenting Market" with Automation

193. MPEP, *supra* note 120, § 706.07(h) (quoting 37 C.F.R. § 1.114(a) (2015)) (defining Request for Continued Examination Practice and stating that even "'[i]f prosecution in an application is closed, an applicant may request continued examination of the application by filing a submission'" and paying additional fees).

194. Spence, *supra* note 176, at 360.

195. *Id.* at 359–60.

196. *See infra* Figure 3.

The introduction of automation technology into patent prosecution quickens the speed of generating patent applications and the pace of providing office-actions responses and presents new automated methods of defensive patenting.[197] However, the speed of automation and growth of defensive patenting do not alter the patenting market model of information feedback.[198] In fact, the conditional probabilistic beliefs of a patent examiner are the same whether or not automation technology is present.[199] Automation technology makes it easier and faster for the inventor to signal to a patent examiner for the examination of a patent application as shown in Figure 3.[200] Unlike predictive analytics, automation does not provide any new information to an inventor and thus does not affect the inventor's signaling to the patent examiner for examination. Therefore, the patent examiner's conditional probabilistic belief remains the same regardless of whether there is automation of patent-application drafting or responses to office actions. However, as shown further in Figure 4 below, the combination of automation and predictive analytics does have an effect on the patent examiner's conditional probabilistic beliefs.[201] To understand the combination effects of automation and predictive analytics, it helps to understand the effects of predictive analytics in isolation. The introduction of predictive analytics modifies the model of information feedback in the patenting market as shown in Figure 4 below.[202]

197. *See supra* Parts I.B.1, I.B.2.
198. Spence, *supra* note 176, at 361.
199. *Id.* at 357–58.
200. *See supra* Figure 3.
201. *See infra* Figure 4.
202. *See infra* Figure 4.

3. *"Patenting Market" with Predictive Analytics*

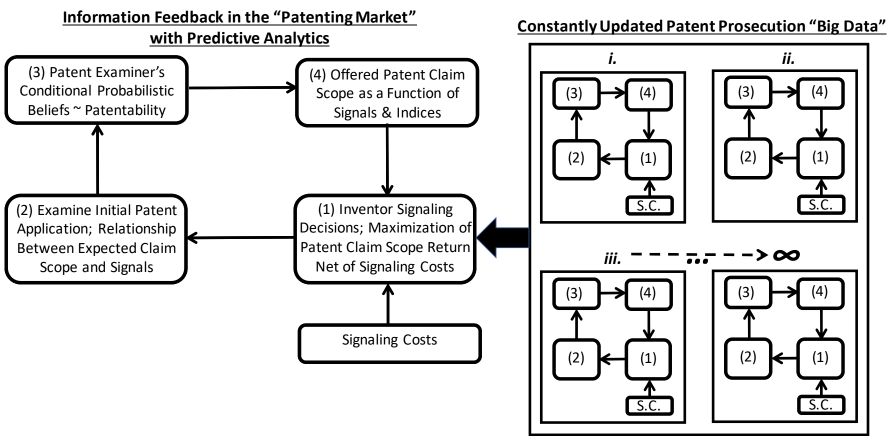

Figure 4: Information Feedback in the "Patenting Market" with Predictive Analytics

In the Spence Model of Information Exchange, the employer's conditional probabilistic beliefs are modified in response to repeated cycles around the loop as new data becomes available to the employer.[203] Thus, the conditional probabilistic beliefs are not only modified by successive waves of new applicants coming into the market but also by new data becoming available.[204] However, unlike the Spence Model of Information Exchange, where an employer attains new data, the inventor (not the examiner) is influenced by new data in the patenting market.

The quid pro quo of the U.S. patent system[205] differentiates information feedback in the patenting market with the Spence Model of Information Exchange feedback. Unlike the employer–employee context, the U.S. patent system provides exclusive rights to an

203. Spence, *supra* note 176, at 360.
204. *Id.*
205. Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 HARV. J.L. & TECH. 531, 542 (2012).

invention with a patent in return for disclosure about how to make and use the invention.[206] Patenting data from the inventor–examiner interactions is publicly available.[207] In effect, each filed patent application and each step of the patent prosecution process generates new patent data.[208] The USPTO shows the aggregate history and new data associated with patent filings and patent-prosecution steps through the Official Gazette[209] and the online PAIR portal.[210] This new patent data has been termed "patent-prosecution big data" by this Article and is based on the ubiquitous term "big data."[211] Patent-prosecution big data represents real-time information that can give a competitive advantage through prediction of market trends.[212]

Whereas an employer's conditional probabilities are modified as new interviewee applicants come into the employer–employee market,[213] conditional probabilities of the patent examiner are modified as new patent-prosecution big data comes into the patenting market. The new patent-prosecution big data, which is equally accessible by the patent examiner and inventors, is continuously updated with each new patent application and new patent-prosecution step. However, the financial management of the USPTO[214] limits patent examiners' use of patent-prosecution big data. Instead, information asymmetries[215] suggest that inventors are more capable of using the patent-prosecution big data, which is shown by a large arrow on Figure 4 for influencing the inventors' signaling.[216] The subset of inventors with resources and access to predictive-analytics technologies would use patent-prosecution big data. In turn,

206. *General Information Concerning Patents*, U.S. PATENT & TRADEMARK OFF., https://www.uspto.gov/patents-getting-started/general-information-concerning-patents [https://perma.cc/8PU3-FZWM] (last visited Feb. 26, 2019).
207. *Id.*
208. *See* Manns & Goeke, *supra* 111, at 4.
209. *See* U.S. PATENT & TRADEMARK OFF., *supra* note 107.
210. *See* U.S. PATENT & TRADEMARK OFF., *supra* note 110.
211. Gandomi & Haider, *supra* note 99, at 138.
212. Giannaccari, *supra* note 108, at 3.
213. *See* Spence, *supra* note 176, at 360.
214. *See supra* Part II.B.
215. *See supra* Part II.B.
216. *See supra* Figure 4.

patent-prosecution big data affects an examiner's conditional probabilistic belief in the model due to the continuous loop nature of the model. Ultimately, inventors' abilities to access and analyze large and unconventional data streams in large-scale patent-prosecution big data influences a patent examiner's conditional probabilistic beliefs through signaling by the inventor in the patenting-market model of Figure 4.[217]

The presence and the influence of patent-prosecution big data disrupts the prospect of information-signaling equilibrium. In Spence's Model of Information Exchange feedback, "signaling equilibrium is generated when [an] employer['s] beliefs are confirmed by the signaling they generate through the offered wage schedule."[218] Additionally, "signaling equilibrium is [the] stable state where sellers (potential employees) in the market differentiate themselves from each other by signaling and thus reduce the information asymmetry between themselves and the buyer (employer)."[219] By analogy, information-signaling equilibrium would be achieved when inventors reduce the information asymmetries between themselves and the patent examiners. Information asymmetries between the inventors and the patent examiners are reduced through the creation and implementation of a counteracting institution at the USPTO.[220] However, departure from information-signaling equilibrium between the inventors and the patent examiners is magnified through the superimposition of automation and predictive analytics as shown below in Figure 5.[221]

217. *See supra* Figure 4.
218. Auronen, *supra* note 1, at 11–12.
219. *Id.*; *see* Spence, *supra* note 176, at 358, 367 (specifying a critical assumption that a signal will not effectively distinguish one applicant from another unless the costs of signaling are negatively correlated with productive capability).
220. *See supra* Part II.C.4.
221. *See infra* Figure 5.

4. "Patenting Market" with Automation + Predictive Analytics

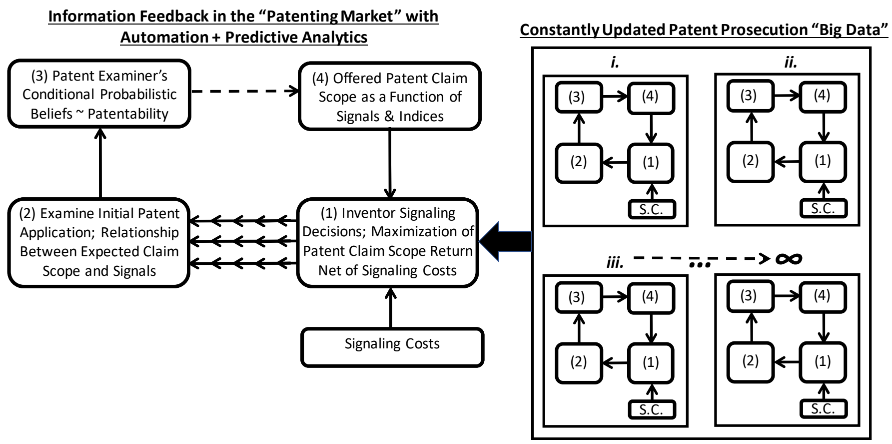

Figure 5: Information Feedback in the "Patenting Market" with Automation + Predictive Analytics

The combination of automation and predictive analytics tips the scale even further away from information-signaling equilibrium between inventors and patent examiners. Although automation alone does not provide information to a patent examiner to affect conditional probability, the combination of automation and predictive analytics does magnify the departure from information-signaling equilibrium.[222] Because automation quickens the patent-application drafting and patent-prosecution response process (see Figures 3 and 5), predictive-analytics effects (shown in Figures 4 and 5) are quickened as well.[223] As shown in Figure 5 above, the multiple arrows emanating from "(1) Inventor Signaling" to "(2) Examine" influence and quicken the effect of predictive analytics later in the loop of information feedback.[224]

222. *See supra* Part II.C.4.
223. *See supra* Figures 3–5.
224. *See supra* Figure 5.

The piecemeal nature of patent prosecution in securing patent rights through claim amendments[225] magnifies the impact of predictive analytics when combined with automation. Inventors may have multiple opportunities to use patent-prosecution big data, including at the patent-application filing stage or with a response to a nonfinal rejection in an office action.[226] For example, an automated response to a first nonfinal rejection in an office action response concerning the business methods arts would magnify the effect of tipping the scale even further away from information-signaling equilibrium when there is a likely subsequent final rejection in an office action and a response to a final rejection in an office action.[227] The reason is that the inventor's capabilities would outstrip those of the patent examiner even more at the subsequent final rejection with the use of patent-prosecution big data at the prior stage of a response to a nonfinal rejection stage. As a result, the combined effects of automation and predictive analytics would further the information-asymmetric effect between inventors and patent examiners during the patent-prosecution process.

III. Policy Considerations & a Reform Proposal

Artificial intelligence technological advancements require answering important legal and policy questions by the USPTO.[228] One consideration is that the transformation of legal decision-making to automated decision-making and to algorithmic processes raises issues of accountability, bias, explainability, transparency, and unfairness.[229] Another related consideration is the effect on the

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225. *See* Chiang, *supra* note 67, at 531–34.

226. MPEP, *supra* note 120, § 706.

227. *Id.* § 706.07(a).

228. Arti Rai, Presentation at the Intellectual Property Law Scholars Conference at University of California-Berkeley: AI and the Patent Office (Aug. 9, 2018), https://www.law.berkeley.edu/wp-content-uploads/2018/07/Arti-Rai.pdf [https://perma.cc/3MMR-ATCE]. *See generally* Deven R. Desai & Joshua A. Kroll, *Trust but Verify: A Guide to Algorithms and the Law*, 31 HARV. J.L. & TECH. 1 (2017).

229. Jennifer Cobbe, Administrative Law and the Machines of Government: Judicial Review of Automated Public-Sector Decision-Making 4–5 (Aug. 6, 2018) (unpublished manuscript), https://ssrn.com/abstract=3226913.

practice and the profession of patent prosecution. Patent attorneys, patent agents, in-house patent counsel, and graduating law students with skills in predictive analytics could distinguish themselves among their peers and become highly sought for patent-prosecution needs in the legal marketplace. However, they could be impacted in negative ways. Artificial-intelligence technology could displace or reduce the need for attorneys[230] in law firms or in-house legal departments and, in doing so, lessen the job opportunities for law students. The impact of decreasing the role of legal-service professionals with new technology affects the relationship between clients and lawyers[231] and, as a result, also affects the relationship of the interaction between inventors and the USPTO.

Some may contend that artificial intelligence is another technological improvement and simply a tool that aids an inventor.[232] This perspective underestimates the impact of artificial intelligence, which has created a paradigm-shifting approach in many legal fields such as patent prosecution. The advent of artificial intelligence will have a more profound effect than other technological developments and, if unaddressed, will create a greater patent-application backlog of business-method patent applications[233] and continually produce computer-generated prior art.[234] The USPTO should become more proactive and undergo infrastructure change or else face severe repercussions.

230. John Flood & Lachlan Robb, Professions and Expertise: How Machine Learning and Blockchain Are Redesigning the Landscape of Professional Knowledge and Organization 3 (Aug. 21, 2018) (unpublished manuscript), https://ssrn.com/abstract=3228950.

231. Michael Guihot, *New Technology, the Death of the BigLaw Monopoly and the Evolution of the Computer Professional*, 20 N.C. J.L. & TECH. (forthcoming 2019) (manuscript at 1), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3238593.

232. Rhys Dipshan, *Enough Hype Already: Inside Legal's (Over?) Excitement with AI*, LAW.COM: LEGALTECH NEWS (Dec. 4, 2018, 9:30 AM), https://www.law.com/legaltechnews/2018/12/04/enough-hype-already-inside-legals-over-excitement-with-ai/ [https://perma.cc/69ZP-GPB7].

233. *See* discussion *supra* Part II.B.

234. *See* discussion *supra* Part I.B.2.

A. Response to Potential Criticism of Artificial Technology as Another Tool

U.S. patent law allows inventors to use tools to aid in drafting and prosecuting a patent application.[235] Inventors have used technologies such as slide rules and calculators for calculations, two-dimensional AutoCAD programs for drafting patent drawings, finite-element analysis for computer simulation and analysis of physics-based principles,[236] and statistical-analysis software packages for parametric studies and for design of experiments.[237] Each of these tools, which aid in the invention process with conception[238] and reduction to practice,[239] has been used and is permissible by U.S. patent law.[240] Moreover, patent attorneys, patent agents, patent analysts, and inventors have utilized patent-analytics software packages to analyze an ever-increasing volume of patent information over the course of many years to provide strategic guidance to inventors in filing patent applications and for scope of coverage.[241]

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235. *See* U.S. PATENT & TRADEMARK OFF., *supra* note 55.

236. DAVID V. HUTTON, FUNDAMENTALS OF FINITE ELEMENT ANALYSIS 1, 4 (2004) (defining the finite element method, which is sometimes referred to as finite element analysis, as "a computational technique used to obtain approximate solutions of boundary value problems [a mathematical problem in which one or more dependent variables satisfies a differential equation everywhere within a known domain of independent variables and satisfies specific conditions on the boundary of the domain] in engineering," such that a finite element solution for a particular problem converges to an exact solution of the problem); WASIM YOUNIS, AUGI DESIGN ACADEMY 2008: AUTODESK INVENTOR PROF. 2 (2008) (describing Finite Element Analysis as a computer-based numerical technique where the component is broken down into many small simple segments or elements, or meshing, so as to reduce or eliminate the need to build prototypes, resolve design problems, reduce failure and warranty costs, and turn around designs faster).

237. SAS INST. INC., JMP 8 DESIGN OF EXPERIMENTS, SECOND EDITION 1 (2009).

238. MPEP, *supra* note 120, § 2138.04 (quoting Townsend v. Smith, 36 F.2d 292, 295 (C.C.P.A. 1929)) (defining conception as "'the complete performance of the mental part of the inventive act' and it is 'the formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention as it is thereafter to be applied in practice . . .'"); Mark A. Lemley, *Ready for Patenting*, 96 B.U. L. REV. 1171, 1177 (2016) (explaining that "conception of an invention does *not* require that the inventor know that the invention will work for its intended purpose" and that conception does not require reduction to practice nor experimentation).

239. MPEP, *supra* note 120, § 2138.05 (stating that reduction to practice, which may be an actual reduction or a constructive reduction to practice, requires recognition and appreciation of the invention).

240. U.S. PATENT & TRADEMARK OFF., *supra* note 55.

241. Assad Abbas et al., *A Literature Review on the State-of-the-Art in Patent Analysis*, 37 WORLD PAT. INFO. 3, 3 (2014) (explaining that the interest in analyzing patent has been for: "(a) determining novelty in patents, (b) analyzing patent trends, (c) forecasting technological developments in a particular

These tools and software packages lessen human involvement or can replicate human ability[242] but are unlike artificial-intelligence technologies that assist in making predictions (or arguably make decisions) that no human could make alone. Artificial-intelligence technology, unlike tools available to inventors in the past, substantially transforms patent prosecution for two reasons: unprecedented technology advancement and data access.

First, artificial-intelligence technologies create a profound change because the underlying speed and depth of mathematical processing capabilities cannot be replicated by any human.[243] Artificial-intelligence technology stems from the advent of powerful computing capabilities,[244] such as high-performance computing[245] and parallel computing,[246] and new research findings in mathematics and computer science. The result is an exponential improvement in tools that can assist humans (or arguably make superhuman decisions) and an exponential increase in data.[247] Artificial-intelligence technology, particularly predictive analytics, provides algorithms that enable the computer to figure out how to do what a human wants to do and enables the computer to learn things that a

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domain, (d) strategic technology planning, (e) extracting the information from patents for identifying the infringements, (f) determining patents quality analysis for R&D tasks, (g) identifying the promising patents, (h) technological road mapping, (i) identification of technological vacuums and hotspots, and (j) identifying technological competitors").

242. *Id.* The tools of the past required a human to give a task with instructions (in the form of software) on how to complete the task, such that the computer performs the task the exact way required by the human. *Id*.

243. *See* discussion *supra* Part I.B.

244. *See generally* Tim Hwang, Computational Power and the Social Impact of Artificial Intelligence (Mar. 23, 2018) (unpublished manuscript), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3147971 [https://perma.cc/4CYJ-5XHY].

245. *See generally* CHARLES SEVERANCE & KEVIN DOWD, HIGH PERFORMANCE COMPUTING (Connexions ed. 2010) (1996), https://cnx.org/contents/u4IVVH92@5.2:bEZZukPR@1/Introduction-to-the-Connexions-Edition.

246. *See generally* JOHN VON NEUMANN INST. FOR COMPUTING, PARALLEL COMPUTING: ARCHITECTURES, ALGORITHMS AND APPLICATIONS (Gerhard Joubert et al. eds., 2007).

247. Ralph Jacobson, *2.5 Quintillion Bytes of Data Created Every Day. How Does CPG & Retail Manage It?*, IBM CONSUMER PRODUCTS INDUSTRY BLOG (Apr. 24, 2013), https://www.ibm.com/blogs/insights-on-business/consumer-products/2-5-quintillion-bytes-of-data-created-every-day-how-does-cpg-retail-manage-it/ [https://perma.cc/ZHF5-XQ49] (stating that 90% of the world's data was created in the last two years and that 2.5 quintillion bytes of data are created every day).

human did not understand or did not anticipate (such as patterns in data).[248]

Second, artificial-intelligence technologies create disparities in access, particularly with data access.[249] Artificial-intelligence methods that make predictions from training data sets give artificial-intelligence-technology owners market power over training capabilities.[250] Moreover, in some cases, artificial-intelligence technology obtains data from whatever sources are available or from whatever data sources it figures out how to access.[251] Unlike past technological tools, artificial-intelligence technology can become more powerful with each use or iteration of the data running through the artificial-intelligence tool.[252] Thus, those with the know-how on training data sets will strengthen their market power due to greater access to use of and improvements to existing artificial-intelligence technology.

B. USPTO Considerations in Response to the Rise of Predictive Analytics

The ramifications for artificial-intelligence technology are profound for the USPTO, inventors, and innovation. Automation technology[253] and predictive-analytics technology[254] change what has been a purely human–human interaction between an inventor and a patent examiner to an interaction involving a machine–human interaction or a machine-assisted element. The back-and-forth

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248. *See, e.g.*, Mohammad Hossein Jarrahi, *Artificial Intelligence and the Future of Work: Human-AI Symbiosis in Organizational Decision Making*, 61 BUS. HORIZONS 577, 578 (2018) (explaining how artificial technology uses algorithms to learn how to do human activities by using the example of IBM's Watson).

249. *CMS: Artificial Intelligence—Data as the New Measure of Competition*, AUTOMOTIVE WORLD (Oct. 3, 2018), https://www.automotiveworld.com/news-releases/cms-artificial-intelligence-data-as-the-new-measure-of-competition/ [https://perma.cc/H34G-EP8T].

250. *Id.*

251. *Id.*

252. *Id.*

253. *See* discussion *supra* Part II.B.

254. *See* discussion *supra* Part II.C.

negotiation[255] in the inventor–examiner interaction[256] is transforming into an interaction in which artificial-intelligence technology significantly outperforms humans and traditional statistical techniques. These changes result in significant policy considerations that require the USPTO to rebalance its policy levers affecting patentability and administrative efficiency.

1. *USPTO's Potential Policy Levers*

Patent-law scholars espouse that the USPTO's ministerial role in the U.S. patent system of examining patent applications and issuing patents keeps the USPTO out of policymaking.[257] However, the USPTO makes policy in disguise, receives specific grants of discretion from Congress, and advances its interpretation of congressional grants.[258] The seemingly expansive role of the USPTO in determining inventors' rights could apply toward the response and policing of artificial-intelligence technologies in the administration of patent examination. Instead of well-documented, regular "fire-alarm" responses to institutional pressures and actors,[259] the USPTO could embark on proactive measures responsive to the advent and proliferation of artificial-intelligence technology in patent prosecution. The USPTO should reevaluate patent-examination policy from economic, fairness, time, and transparency perspectives to balance the use of artificial intelligence between various actors.[260]

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255. Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U. L. REV. 63, 66 (2004).

256. *Id.* The inventor may be represented by a patent attorney or patent agent in the use of the phrase "inventor–examiner interaction." *Id.* For the sake of simplicity, it is assumed that the word "inventor" in the phrase "inventor–examiner interaction" can refer to any inventor, patent attorney, or patent agent. *Id.*

257. Sarah *Tran*, *Policy Tailors and the Patent Office*, 46 U.C. DAVIS L. REV. 487, 491–92 (2012).

258. Saurabh Vishnubhakat, Disguised Patent Policymaking 3 (Aug. 27, 2018) (unpublished manuscript), https://ssrn.com/abstract=3242146 [https://perma.cc/A5KH-7FQ3].

259. *See* David Orozco, *Administrative Patent Levers*, 117 PENN ST. L. REV. 1, 10 (2012).

260. *See infra* Part III.C. This Article does not delve deeply into all of the policy considerations and highlights three (fairness, transparency, and time) of the four perspectives the USPTO should consider in response to artificial technology advancements. However, this Article does provide a detailed perspective of the economics-based perspective as a conceptualization and as a potential responsive reform proposal in Part III.C.

First, an economics-based response by the USPTO to artificial-intelligence technology could seek to equalize the inventor–USPTO power distribution. This view would analyze the human–human versus human–machine scenario created by the adoption of artificial-intelligence technology outside of the USPTO at a faster pace than inside of the USPTO.[261] A counteracting artificial-intelligence institution that would serve as a guarantor of artificial-intelligence creations is one economics-based balancing consideration.[262]

Second, a fairness-based perspective would equalize access to artificial-intelligence technology between solo inventors, startups, small businesses, and larger companies. Currently, the USPTO grants far more patents to large, multi-billion-dollar companies than to smaller companies.[263] Artificial-intelligence technology would widen the USPTO patent-grant gap between larger and smaller companies. A fairness-based analysis would provide artificial-intelligence capabilities to resource-limited companies and inventors to balance the resource-rich capabilities of larger, multinational companies. The USPTO, which has the authority to set its own fees,[264] could vary its fee structure to balance fairness among small and large companies. Thus, the USPTO's ability to tweak its fee schedule for various facets of patent prosecution[265] could affect the use of artificial technology for patent prosecution. For example, fee increases in patent prosecution could reduce activities of large, multinational companies or other entities that utilize their resources to flood the USPTO with

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261. *See infra* Part III.C.

262. *See* Tran, *supra* note 257, at 530–31.

263. Samuel Stebbins, *The World's 50 Most Innovative Companies*, USA TODAY (Jan. 12, 2018, 8:00 AM), https://www.usatoday.com/story/money/business/2018/01/12/worlds-50-most-innovative-companies/1023095001/ [https://perma.cc/FA4G-6JBY] (specifying that four U.S. companies—Apple, Google, Microsoft, and Amazon—accounted for about 30% of the granted patents; providing a list of fifty companies, all of which are major multinationals, that were granted a majority of the more than 320,000 patents by the USPTO in 2017).

264. *See* Tran, *supra* note 257, at 500.

265. *USPTO Fee Schedule*, U.S. PATENT & TRADEMARK OFF., (Mar. 1, 2019), https://www.uspto.gov/learning-and-resources/fees-and-payment/uspto-fee-schedule [https://perma.cc/7MES-RV8J].

automated patent applications, such as in the business-method art units. Fee decreases in patent prosecution could increase the use of artificial-intelligence technology for patent prosecution, thereby increasing the number of filed patent applications because the technology would permit lower legal labor costs with drafting patent applications and responding to office actions.

Third, a transparency-based view would consider altering the availability of patent-prosecution data. Currently, patent-prosecution histories, which are constantly updated with new patent-prosecution and patent-filing information, are available to the public.[266] Surprisingly, the level of patent-prosecution data transparency can affect the impact of artificial intelligence by a party due to the ability to train data sets.[267] For example, inventors and organizations with greater artificial-intelligence capabilities will benefit from more transparency of patent-prosecution data because they can develop training capabilities that will shed insights as more data becomes available. Thus, the USTPO can respond to artificial-intelligence-technology advancement by tweaking the level of transparency or availability of patent data to the public. Although the quid pro quo of the U.S. patent system[268] requires disclosure for limited exclusivity in patent rights, mechanisms like the requests for nonpublication[269] and secrecy orders[270] are limitations to full disclosure. For example, the USPTO can develop and make available the use of predictive-analytics tools and results to the public, which would lessen the market power of resource-rich organizations and strengthen the market power of resource-weak organizations that are unable to develop predictive-analytics capabilities.

Fourth, a time-based view considers altering the amount of time for patent grants. One scholar has called for weakening patents by 25–50% by shortening the patent term due to decreased cost of

266. *See* U.S. PATENT & TRADEMARK OFF., *supra* note 107.
267. *See* AUTOMOTIVE WORLD, *supra* note 249.
268. *See* Spence, *supra* note 176, at 360.
269. MPEP, *supra* note 120, § 1122.
270. *Id.* § 106.

innovation brought about by digitization in emerging technologies.[271] Artificial intelligence is another digital technology that can lessen the value of patents by weakening the patent-prosecution process. Thus, Congress can respond to artificial-intelligence technology's impact on patent prosecution by weakening the exclusivity period for patent protection and, in doing so, reduce the weakening effect of artificial intelligence on patent prosecution.[272]

2. *USPTO Initial Response & Early Efforts Are Not Enough*

The USPTO is aware of the advent and proliferation of artificial-intelligence technology.[273] In response, the USPTO has created a Request for Information (RFI), a conference, a technical report, and exploratory projects.[274] The USPTO's Chief Information Office has created a RFI that seeks innovative solutions to help it determine whether a patent application is unique.[275] The RFI requested that the public or private organization provide information to aid in the development of a plugin or technology[276] to augment the USPTO's current capabilities.[277] Moreover, the USPTO's Office of

271. Lucas S. Osborn et al., *A Case for Weakening Patent Rights*, 89 ST. JOHN'S L. REV. 1185, 1190–91 (2015) (arguing that emerging digital technologies, such as the internet, 3D printing, and synthetic biology, have lessened the need for intellectual property protection).

272. *Id.* For example, a 50% less exclusivity period could lessen the desire to automate patent drafting and responses to office actions, develop computer-generated prior art, and utilize predictive analytics in patent prosecution. *See generally id.* However, it should be reiterated that defensive patenting with artificial intelligence can strengthen the value of patents. *See supra* Part II.B.2. Thus, Congress should consider variables for and effects of changing patents' exclusivity period in response to artificial intelligence.

273. Andrei Iancu, Dir., U.S. Patent & Trademark Office, Remarks at the Artificial Intelligence: Intellectual Property Considerations Event (Jan. 31, 2019), https://www.uspto.gov/about-us/news-updates/remarks-director-iancu-artificial-intelligence-intellectual-property [https://perma.cc/V9PM-YCYB].

274. *See supra* Part III.B.2.

275. *Patent Office Issues RFI to Improve Patent Prosecution*, MERITALK (Sept. 14, 2018, 3:46 PM), https://www.meritalk.com/articles/patent-office-issues-rfi-to-improve-patent-prosecution [https://perma.cc/ES5J-HA7S] (describing that the RFI seeks solutions that effectively segment information, retrieve the most relevant results, summarize documents to determine if the information is relevant, and identify whether a search has adequately reviewed possible results; wherein the RFI appears to seek a tool to help patent examiners with searching capabilities and with organizing search results).

276. *Id*.

277. *Id.* Although it is conceivable that a member of the public would want to help the USPTO with

Policy and International Affairs (OPIA) has organized a conference titled, "Artificial Intelligence: Intellectual Property Policy Considerations."[278] Also, the USPTO has published a technical report and exploratory efforts that suggest that it is in the early stages of research into artificial-intelligence-technology applications for its operations.[279] Additionally, the USPTO has indicated that it is starting exploratory projects for artificial intelligence information technology.[280] These efforts demonstrate emphasis on search capabilities that could make a patent examiner's task easier for searching prior art. However, none of these initiatives provide a strong policy-driven response to the advent and proliferation of artificial intelligence. The USPTO has not developed a plan that responds to automation technology's ability to create a flood of business-methods patents that can be easily produced by automated

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providing a search solution, it is likely that such a capability would be valuable to a company and may not reach or be provided to the USPTO. *Id.*

278. *Artificial Intelligence: Intellectual Property Policy Considerations—NEW DATE*, U.S. PATENT & TRADEMARK OFF., www.uspto.gov/about-us/events/artificial-intelligence-intellectual-property-policy-considerations [https://perma.cc/FS6Q-779V] (last visited Mar. 5, 2019). The AI Conference at the USPTO headquarters on January 30, 2019 involved discussions about the following questions:

> [(i)] How is AI being used to enforce IP rights, protect inventions, and create new business models?
> [(ii)] How will AI alter the management and organization of research, innovation, and commercialization?
> [(iii)] What are the copyright implications when AI is used to create new works or when copyrighted works are used to "train" artificial intelligence systems?
> [(iv)] How will AI affect trademark protection and branding?
> [(v) How do we ensure transparency and guard against bias without sacrificing the competitive edge that helps fuel innovation and commercial activity surrounding AI?]

Id.

279. Arthi Krishna et al., *Examiner Assisted Automated Patents Search*, 2016 ASS'N FOR ADVANCEMENT ARTIFICIAL INTELLEGENCE FALL SYMP. SERIES 153, 153 (describing the development of a search system with several layers of augmented processing that can be controlled and modified as the search progresses, with the goal of providing transparency and control by users; detailing a search algorithm that performs text analysis and retrieval, annotations, synonym generation, and user interactions; and explaining the published technical report indicates the development of a search tool that will automate prior art searching and assisting patent examiners in finding and making decisions in the prior art).

280. U.S. PATENT & TRADEMARK OFFICE, PATENT PUBLIC ADVISORY COMMITTEE QUARTERLY MEETING: IT UPDATE 10 (2018) (suggesting exploratory projects at the USPTO for AI based Patent Term Library Generator, AI based Image Search, and Deep Machine Learning Chat Bots).

patent-drafting tools[281] and that could tackle computer-generated cloem permutations of potentially alternative inventions.[282] The current backlog of patent applications at the USPTO[283] could grow with an increase in easily and quickly prepared business-methods patent applications through automation. Patent examination may need to search and analyze an increasingly larger universe of computer-generated prior art, causing patent examiners to be inundated with arduous and lengthy prior-art searches that require a different course of action.

C. Reform Proposal: Counteracting Artificial Intelligence Institution

The USPTO's response to artificial-intelligence-technology advancements has been slow, and initial actions such as establishing a RFI, a conference, a technical report, and exploratory projects suggest that more could be done.[284] The USPTO has been slower to react to artificial-intelligence technology and its effect on patent-office operations in comparison to other countries' patent offices.[285] The Japan Patent Office announced publicly that it is investing in the use of artificial-intelligence technology to automate screening patent applications.[286] Unlike the Japan Patent Office, which has automated patent-literature reviews, developed search algorithms to identify similar prior art, and automated classification of patent application by fields,[287] the USPTO's artificial-intelligence efforts have been limited to brainstorming and plans.[288]

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281. *See supra* Part I.B.1.
282. *See supra* Part I.B.2.
283. U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2016 3 (2016) (stating that the current backlog of unexamined patent applications stood at about 540,000 in 2016 and is down from the 750,000 unexamined patent application in 2009).
284. *See supra* Part III.B.2.
285. Iancu, *supra* note 273.
286. Bob Stembridge, *Artificial Intelligence: Hype vs. Reality and the Impact on the Patent Industry*, CLARIVATE ANALYTICS: BLOG (Aug. 8, 2018), https://clarivate.com/blog/ip-standards/artificial-intelligence-hype-vs-reality-impact-patent-industry/ [https://perma.cc/6ZEM-XFBX].
287. *Japan Looks to AI to Simplify Patent Screening: Technology Will Automate Complex Tasks with Pattern-Matching*, NIKKEI ASIAN REV. (Apr 24, 2017, 4:30 AM),

Instead, the USPTO should create a counteracting artificial-intelligence institution.[289] The proposed USPTO artificial-intelligence institution should serve as a guarantee of patent applications derived from artificial intelligence, responses to office actions, and prior art. The proposed USPTO artificial-intelligence institution should also track and evaluate advancements in artificial-intelligence technology, including patent-prosecution big data, and should train and educate other art units of developments. The introduction of a counteracting institution is justified by economics principles.[290] A counteracting institution can serve as a market intermediary to reduce the asymmetry of information between parties in a market.[291] One of these institutions is guarantee of goods that can allow the buyer sufficient time to reach the same level of information about the good as the seller.[292] The counteracting institution prevents the reduction of the average quality goods caused by the seller's incentives to sell below-market-quality goods in an information-asymmetric exchange.[293] As an analogy to the patenting market,[294] the inventor (a seller of inventions) would provide lower quality goods (inventions) with artificial-intelligence technology in

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https://asia.nikkei.com/Economy/Japan-looks-to-AI-to-simplify-patent-screening [https://perma.cc/LB3C-SHXV]. The Japan Patent Office will:

> [A]pply AI tech as early as the April 2018–March 2019 fiscal year to 20 tasks where ample documentation exists to train software and for which pattern analysis and recognition, the technology's specialty, is expected to prove useful.
>
> . . . .
>
> The office will begin [in summer 2017] testing in six of the 20 tasks for accuracy and cost-effectiveness. The rest will be tested in stages starting [in 2019].
>
> Since . . . December [2017], the office has used an AI system to generate responses to patent queries.

Id.

288. *See supra* Part III.B.2.

289. *See supra* Part II.C. The inventor–examiner interaction conceptualization (regarding reducing information asymmetry) demonstrated the influence of artificial intelligence, and the "lower quality goods" herein is a consequence of that asymmetry. *See supra* Part II.C.

290. *See* Auronen, *supra* note 1, at 9.

291. *Id*.

292. *Id*.

293. *Id*. at 7.

294. *See supra* Part II.C.

an information-asymmetric inventor–examiner exchange; therefore, economics suggests that a counteracting institution (a proposed USPTO artificial-intelligence institution) would prevent the reduction of the average quality of goods (inventions).

Such a USPTO artificial-intelligence institution can further be justified from the perspective of Spencian signaling.[295] When artificial-intelligence technologies cause disparities among inventor patent applicants,[296] parties lacking artificial-intelligence capabilities will benefit from Artificial Intelligence Spencian Signaling when a counteracting artificial-intelligence institution is created at the USPTO. In other words, if the USPTO creates a counteracting artificial-intelligence institution, Artificial Intelligence Spencian Signaling would apply to U.S. patent examination where inventor patent applicants would seek to signal to the USPTO that their inventions were not produced with artificial-intelligence technology, thereby narrowing the identification gap for a patent examiner. Thus, the signaling discussion herein sets the theoretical foundation in light of the proposed counteracting artificial-intelligence institution. As it relates to Spencian signaling, there will be observed gaps between a patent applicant (a potential patentee) and the USPTO (an organization) when USPTO was to create a counteracting artificial-intelligence institution.

The proposed USPTO artificial-intelligence institution can embark on a number of actions with economic justifications. For example, the proposed USPTO artificial-intelligence institution can filter computer-generated cloems and computer-generated prior art[297] representing nonsense that uses search time and cost in prior-art searches by patent examiners. Moreover, the proposed USPTO artificial-intelligence institution can identify which inventors and organizations are submitting a flood of patent applications with minute changes among them, thereby indicating a high likelihood of

295. *See supra* Part II.C.
296. *See infra* Part III.B.1.
297. *See supra* Part I.B.2.

automated patent applications. Additionally, the proposed USPTO artificial-intelligence institution can develop predictive-analytics capabilities, from which it can identify patterns in data and take responsive actions to prevent opportunistic patenting by inventors. For example, if predictive-analytics capabilities identify a particular patent examiner that allowed disproportionately more patent applications to issuance in a particular art unit, then the USPTO can proactively shuffle its patent examiners in that art unit to prevent opportunistic patenting by inventors and corporations that come to similar determinations from their use of predictive analytics. Although such a USPTO action would require approval from a strong and resistant professional union of U.S. patent examiners, POPA,[298] it would provide a countermeasure to private-sector parties that attempt to opportunistically take advantage of the patent system with artificial-intelligence capabilities. Each of these examples is based on economic phenomena and helps to equilibrate the level of information available to the inventor and examiner concerning the invention.

Currently, the USPTO's slow pace in responding to artificial-intelligence technology has resulted in an inventor–examiner patenting market[299] with a human–machine-versus-human mismatch. The proposed USPTO artificial-intelligence institution would lessen the degree of information asymmetry and reformulate the inventor–examiner interactions because both parties would possess artificial-intelligence capabilities. One study has concluded that the degree of asymmetry of information lessens between two parties that each possess artificial-intelligence agents.[300] The USPTO should utilize economic theory to create an artificial-intelligence institution and, in doing so, enable a more efficient patenting market.[301]

298. PAT. OFF. PROFS. ASS'N, *supra* note 165.
299. *See supra* Part II.C.
300. *See* Marwala & Hurwitz, *supra* note 134.
301. *See supra* Part II.C.

CONCLUSION

Artificial-intelligence technology is transforming the field of patent prosecution. Automation simply quickens the pace of patent-application drafting and response to office actions. Automated computer-generated prior art will burden patent examiners and the USPTO. Predictive analytics transforms the inventor–examiner exchange by making the conceptualized patenting marketing to be one-sided unless the USPTO responds with proactive measures. The USPTO should develop a counteracting artificial-intelligence institution to counteract the private sector's resources. The USPTO's limited efforts in addressing artificial-intelligence technologies could have negative consequences in the examination of patent applications and to the patent-prosecution profession.