WORKING PAPER

Who owns artificial intelligence? A preliminary analysis of corporate intellectual property strategies and why they matter

Nathan Calvin and Jade Leung[1]
Centre for the Governance of AI
Future of Humanity Institute, University of Oxford

February 2020

[1] For comments and ideas we thank Markus Anderljung, Miles Brundage, Allan Dafoe, Jeffrey Ding, Carrick Flynn, Rose Hadshar, Carin Ism, Saif Khan, Brian Tse, Baobao Zhang, and Remco Zwetsloot. Special thanks to Cullen O'Keefe, who provided crucial input on several drafts, Emefa Agawu, for substantial support improving the structure and content of the report, and Emmie Hines, for proofreading and copyediting support. This work was funded by the Berkeley Existential Risk Initiative. All errors are ours alone.

Summary and Key Takeaways

This working paper is a preliminary analysis of the legal rules, norms, and strategies governing artificial intelligence (AI)-related intellectual property (IP). We analyze the existing AI-related IP practices of select companies and governments, and provide some tentative predictions for how these strategies and dynamics may continue to evolve in the future. In summary:

- AI developers use a mix of patents, trade secrets, and open-source licensing agreements to protect their AI-related IP.
- Many AI companies are pursuing what may seem like a counterintuitive IP strategy: aggressively patenting AI technologies while sharing them freely. They experience competitive pressure to patent in order to present the threat of a countersuit if another company sues them for IP infringement. However, they also experience pressure to open-source their work in order to attract top talent and entice consumers to use their platforms.
- Governments broadly have two goals related to IP policy for AI that are at times in conflict with the goals of researchers and/or companies: to ensure that AI-related inventions can be patented, and to ensure that national-security-relevant AI inventions are restricted for government use and/or kept secret.
- Significant uncertainty exists regarding how AI patentability, open-sourcing, and infringement litigation will evolve in the future.
- There is an opportunity for patent pools to be used to facilitate pro-social behavior and ethical norms among AI developers. Existing patent pools and practices by international standards organisations represent possible models to replicate.

Table of Contents

1. Introduction

Artificial intelligence (AI) is increasingly a focal point of competition between leading firms, and between states. This paper focuses on a key, often under-examined component of the competitive strategies being employed by both corporate AI developers and national governments: the protection of their intellectual property.

Intellectual property (IP) is a broad and flexible concept, referring to creations of the mind that are eligible for protection through law.[2] Today, companies are using a mix of patents, trade secrets, and open-source licensing agreements to protect their AI-related IP. Simultaneously, government patent offices, judiciaries, and national security apparatuses are deciding which aspects of AI should be patentable, and whether certain inventions should be restricted for military purposes.

The IP policy choices that governments and corporations make can have profound implications for the development trajectory of a technology. For example, in the 1990s, the biotechnology industry was transformed after court decisions in the US enabled a broader range of biological compounds and processes to be protected by patent law. This development spurred additional private investment, but critically also allowed companies to claim ownership over what previously would have been considered basic academic research. This, in turn, encouraged higher levels of secrecy to protect valuable intellectual property.[3] More recently, one of the most prominent advances in biotechnology, the CRISPR gene editing mechanism (originally derived from a naturally occurring process in bacteria), has been subject to a protracted legal battle over overlapping patent claims in the US.[4]

Changes in IP law and strategy may have a similarly large impact on the trajectory of AI development. What these impacts could be, however, have received little study. This paper aims to provide a preliminary analysis of the goals and strategies of corporations and governments focused on AI development, and what the implications of these strategies may be. First, we explain how corporate AI developers currently protect their AI-related intellectual property and why they choose the methods that they utilize. Second, we describe how governments use intellectual property law to pursue national goals related to AI. Finally, we describe three plausible scenarios for how IP strategies in AI may evolve.

[2] World International Patent Organization

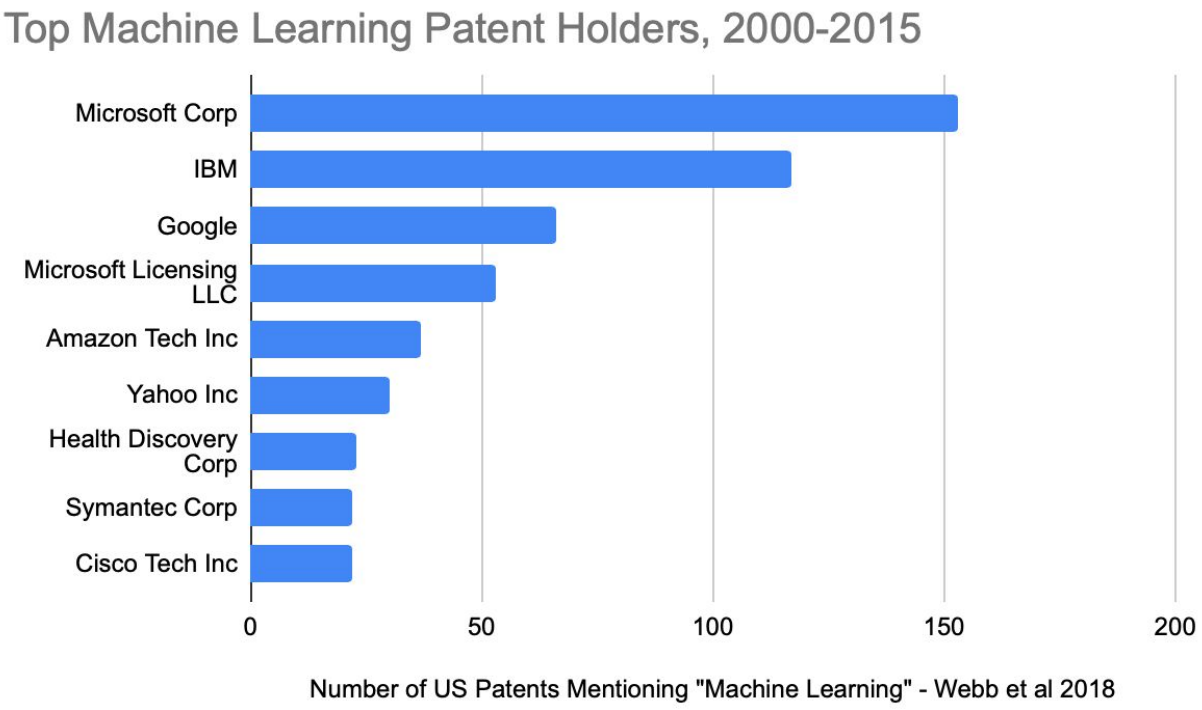
[3] World International Patent Organization

[4] Cohen, 2019

2. Understanding Corporate AI Developer IP Strategies

Corporate AI developers face two key decisions around how to protect their AI-related intellectual property: whether or not to patent AI techniques and systems, and whether to open-source models or keep them private as trade secrets.

A prevalent strategy among top AI developers today involves accumulating patents while simultaneously sharing research with the open-source community.[5] For example, Microsoft holds the most number of machine learning patents in the US (see Figure 1),[6] but is also an active participant in the open-source community,[7] sharing source code for machine learning methods and under certain circumstances providing free licenses for their patents. Microsoft's strategy is not an anomaly. Amazon, Google, IBM, Facebook, Baidu, Tencent, and several other companies are prolific patent holders in AI (see Figures 1 and 2) while also open-sourcing substantial portions of their systems and sharing their work at academic conferences such as ICML and NeurIPS.[8]



[5] There are, however, exceptions. AI developers that specialize in work with national security and more hardware centric applications rely on trade secrets more and open-source less. Our analysis does not explicitly investigate trade secrets, as this information is particularly difficult to obtain.

[6] Webb et al., 2018

[7] Microsoft

[8] Amazon Web Services; Cai, 2018; IBM 2018; Baidu

Figure 1: Top Machine Learning Patent Holders, 2000–2015

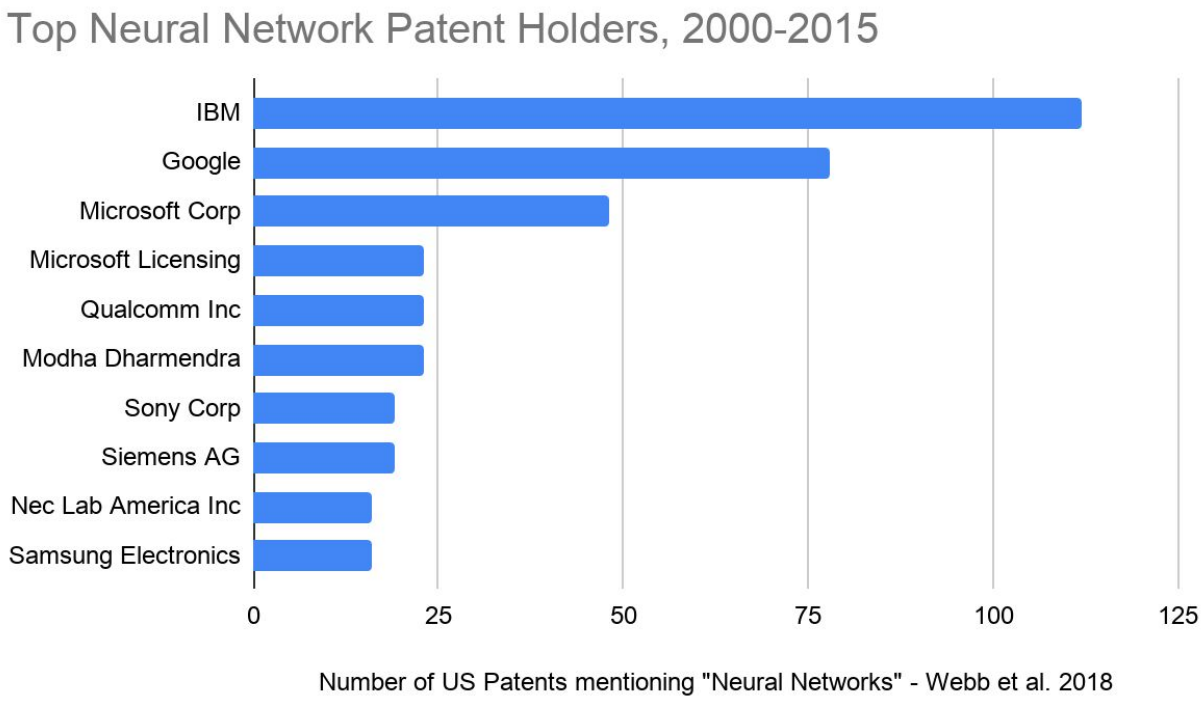


Figure 2: Top Neural Network Patent Holders, 2000–2015

Notably, and perhaps unintuitively, some of the largest software patent holders in the world (Google, Amazon, and Facebook) signed an amicus brief[9] to the Supreme Court in 2014 advocating that the court invalidate most kinds of software patents, which includes the majority of AI and ML patents. These observations beg the question: why do so many of the top AI developers grow AI-related patent portfolios while simultaneously sharing their research at academic conferences, open-sourcing machine learning models, and advocating for the legal dissolution of many AI-related software patents?

In this section we argue that these corporate IP strategies help to manage a variety of objectives that companies wish to pursue. AI developers apply for patents because of competitive pressures to do so. These same developers also often open-source AI models in order to build their reputation, attract talent, and incentivize customers to use paid products. AI developers can also use selective open-source licensing agreements as a hybrid strategy, enabling companies to participate in the open-source community while maintaining the legal threat of their patents. We discuss these incentives for both patenting and open-sourcing in turn, along with limitations and drawbacks of each approach.

[9] Alice Corp v. CLS Bank International, 2014

Pressure to Patent

Patents have several uses beyond simply enabling the patent holder to sue for patent infringement. In the case of big technology firms, there is a strong incentive to engage in "defensive patenting;" that is, patenting without the intention to offensively litigate for infringement, but rather to present a credible threat of counter-lawsuit to another company. Google senior patent counsel Suzanne Michel explained this defensive motivation for building up a large patent portfolio during a 2013 symposium at American University:

> *"If everybody else is running after every trivial patent and building a big portfolio, you have to too. ... It is called mutually assured destruction. That is the dynamic. ... You cannot opt out of the patent system and decide 'I am an open-source company and anyone can use my stuff.' You have to have a massive portfolio of your own and that is really expensive and it is what it is."*[10]

As the "mutually assured destruction" analogy makes clear, patent litigation is extremely costly for all involved due to substantial legal fees and the stigma for investors of working with a company whose products are in legal purgatory. At the height of smartphone-related litigation in 2011, Apple and Google each spent more money on patent litigation (primarily in suits and countersuits against one another) than they did on research and development, a sum in the billions of dollars.[11] In that same year, Google spent $12 billion acquiring Motorola, which market analysts evaluated as being primarily for Motorola's substantial smartphone patent portfolio.[12] Perhaps if Google had acquired Motorola's patents before litigation began with Apple, the threat of a more substantial retaliation could have prevented the lawsuits.

This defensive rationale is also the stated reason for Google's new AI patent filings in machine learning and neural networks. When asked about Google's new filings, spokespeople for Google and DeepMind stated that they "hold patents defensively, not with the intent to start fights with others."[13] This dynamic can also help explain why Google has advocated for narrowing the influence of software patents while simultaneously growing its own patent portfolio; while Google may prefer a world without expensive software patent litigation, its defensive patenting strategy is shaped by threats in the existing patent litigation regime.

Beyond defensive patenting, corporate AI developers could also be incentivized to hold patents in order to gain leverage in other settings. For example, Google's patent sharing arrangement with the Chinese tech giant Tencent is paving the way for Google's entry into the Chinese market.[14] Google also allows other companies to enter into its "Open Patent Pledge" and make use of patents in a pool as long as they commit not to engage in patent litigation against Google.[15]

---

[10] Quinn, 2013
[11] Duhigg and Lohr, 2012
[12] Hardy, 2011
[13] Simonite, 2018
[14] Cadell, 2018
[15] Google

However, building and maintaining a large patent portfolio has its drawbacks. First, in the US, patent holders must pay substantial upkeep fees to keep their patents active; up to thousands of dollars a year depending on the size of the patent holding entity and age of the patent (see Table 1).[16] For large companies like Google—which has more than 50,000 active patents—these costs can be in the tens of millions of dollars.[17] Second, for companies that place a high premium on secrecy, the disclosure requirements and public nature of patent filings may be onerous. Finally, some in the AI research community are philosophically opposed to the idea of patenting AI concepts and techniques, particularly broad theoretical methods that are seen as mathematical truths rather than human inventions.[18] Companies that do choose to patent regardless may face pushback from those opposed, which may have flow-on effects on their ability to, for example, attract and retain research talent.

Patent Fee Schedule (per patent)[19]	**Large Entity Fee**	**Small Entity Fee**	**Micro Entity Fee**
Patent Maintenance fee due 3.5 years after patent is issued	$1,600	$800	$400
Patent Maintenance fee due at 7.5 years	$3,600	$1,800	$900
Patent Maintenance fee due at 11.5 years	$7,400	$3,700	$1,800

Table 1: USPTO patent upkeep costs, per patent

Pressure to Open-Source

Incentives for corporate open-sourcing are also complex, typically extending beyond an altruistic or philosophical belief in open science. For example, open-sourcing can be used to build a firm's reputation, generate goodwill among the research community, and encourage customers to use paid products.

Apple's recent trend towards open-source and sharing more AI research demonstrates some of these incentives at work. Apple has a notorious culture of secrecy, with numerous internal mechanisms in place to prevent leaks and sequester information.[20] Apple has benefited from this culture of secrecy in consumer hardware design, a world where preventing leaks and copycat designs are critically important. However, this culture was also a barrier for Apple to recruit top ML researchers, who typically strongly value being able to publish and share their work at conferences. Notably, several of Apple's rival firms enabled researchers to do so.[21] In 2017, Apple

[16] US Patent and Trademark Office
[17] Regalado, 2013
[18] For an example of this view, see Mark Riedl's quote in Simonite, 2018
[19] US Patent and Trademark Office
[20] Stone and Vance, 2009
[21] Clark, 2015

changed its approach, launching a machine learning journal and enabling its researchers to publicly share findings at top ML conferences, including NeurIPS and ICML.[22]

Open-sourcing can also be used as a tool to generate more paying customers. For example, companies with substantial cloud computing businesses often offer free machine learning tools to encourage customers to design an application using the open-source tool. Then, these customers go on to pay for these compute-intensive machine learning processes to be implemented on that same firm's cloud service. In some cases, this occurs through explicit lock-in. For example, Amazon's image recognition software "Rekognition" is only available on Amazon Web Services.[23] In other cases, companies aim to retain customers through brand loyalty; Google hopes that customers will use its ML open-source platform Tensorflow on Google Cloud, though they could also use it on Amazon Web Services or Microsoft's Azure. This proves to be a strong incentive for open-sourcing given that cloud services appear to be incredibly lucrative. In 2018, Amazon, Microsoft, and Google earned $25 billion, $23 billion, and $4 billion in revenue from their cloud businesses, respectively.[24] IBM's $34 billion acquisition of open-source cloud computing provider RedHat (which reportedly was also in acquisition talks with Google, Microsoft, and Amazon before selling to IBM[25]) and Microsoft's $11 billion JEDI cloud computing contract with the Pentagon[26] further show how cloud business is a priority for large AI developers.

The major downside of open-sourcing is the opportunity cost: open-sourcing in its purest form means forgoing licensing fees from users. It also means sharing what would otherwise be competitive secrets with rival companies. In the next section we discuss some ways that companies manage to avoid these drawbacks.

A Hybrid Strategy: The Best of Both Worlds?

Despite the apparent conflict between building a large patent portfolio and participating in the open-source community, selective licensing rights can enable a hybrid strategy where companies participate in the open-source community while maintaining their patents. Companies can and do create selective licensing terms for the use of their patents in open-source projects. These agreements can include defining permitted usage in a way that allows some users to utilise the code while forbidding competitors to include that code in a product.[27]

AI developers have also used selective open-source licensing agreements to achieve other ends. In 2019, Microsoft offered open-source Azure cloud users access to a substantial portion of their patents as an incentive for users to join the platform.[28] Facebook attempted to add a licensing stipulation to its popular open-source

[22] Lewsing, 2017
[23] Amazon Web Services
[24] Griswold, 2019; Microsoft, 2018; Novet, 2018
[25] Peterson, 2018
[26] New York Times, 2019
[27] E.g. The GNU Operating System GPL3 Open-Source license forbids commercial use.
[28] Microsoft

platform React, which would have caused users to retroactively lose their licenses if they ever engaged in patent litigation against Facebook.[29]

3. Governments' Pursuit of AI Innovation and National Security Through IP Law

Governments around the world are grappling with how to best take advantage of the recent wave of advances in AI, with several nations releasing national plans on how their country intends to incentivize and capitalize on AI innovation.[30] These plans include ensuring that effective IP law regimes exist for AI and ML. This tends to break down into two objectives: making AI patentable, and regulating access to national security related IP. (For additional context on how national patent systems interact at the international level, see Box 1.)

Box 1: The International Patent System and the World Intellectual Property Organization

Patent systems are primarily domestic in nature rather than international. Each country has its own patent office and companies interested in seeking a patent for an invention must apply separately in all jurisdictions in which they wish to be awarded a patent.[31] A patent awarded in one country cannot be used to litigate infringement in another, though that patent does count as a form of "prior art" which can be used to prevent the award of a patent for that invention in another country. The World Intellectual Property Organization helps harmonize this process by assisting inventors to file their inventions in several jurisdictions at once. However, the decision to award a patent will ultimately fall to individual countries.

While patent treaties such as "The Agreement on Trade-Related Aspects of Intellectual Property Rights" (TRIPS[32]) have taken steps to harmonize intellectual property law across member nations, differences persist at every level of the process: what inventions are patentable, the level of scrutiny applied before a patent is granted, how patents are enforced and reviewed, the length for which patents are valid, and upkeep costs required to maintain the patent.

Making AI Patentable

A prominent element of several AI national plans is to ensure that AI-related inventions can receive patents in a timely fashion. The goal of this policy is to encourage research and development (R&D) investment in AI by rewarding that investment with a potentially lucrative patent. This strategy functions to both encourage domestic companies to invest in AI-related research, and entice corporations choosing between different IP systems to set up shop in their country rather than elsewhere.

[29] The plan was abandoned after developer backlash. See Wolff, 2017

[30] Dutton, 2018

[31] World International Patent Organization, 2017

[32] Agreement on Trade-Related Aspects of Intellectual Property Rights, 1995

For example, US Patent and Trademark Office Chief Andrei Iancu recently expressed in a Senate hearing that the US needs to make sure that its IP rules adequately protect and incentivize innovation in AI.[33] In China's state council plan, which declared the nation's intention to be the world leader in AI by 2030, one section advised that policy makers in China must "[s]trengthen the protection of intellectual property in the field of AI."[34] The European Patent Office also recently released specific guidance on how to successfully patent inventions in AI and machine learning,[35] and Singapore is allowing AI patents to be "fast tracked" for review through its patent system.[36] Proposals for increasing Britain's competitiveness in AI have also highlighted its patent system's challenges in protecting AI-related inventions as a liability.[37]

In some ways, the question of how to create patent protections for AI is not a new one. AI patents mostly fall into the existing category of software patents, and countries have struggled for years to find regulatory structures that incentivize innovation without allowing individual companies to control overly broad, abstract, or obvious ideas.[38] In fact, despite a push to allow more patenting and offer more stringent protections for inventions, two recent major changes in IP law within the United States—the 2011 America Invents Act[39] and the 2014 Supreme Court decision *Alice Corp. v. CLS Bank International*[40]—made it more difficult to claim and enforce broad software patents. It will be difficult to change patenting rules in AI without also implicating these existing decisions on software patents.

Furthermore, it is unclear whether expanding the range of patentable AI-relevant inventions would effectively incentivize innovation. For one, AI and ML commercial activity has experienced massive growth and international investment even while the patentability of innovations remains uncertain, suggesting that the ability to patent AI is not necessary for innovation. In addition, more patents increases the likelihood of litigation, which could act to disincentivize innovation and slow down industry growth. This is particularly a concern for software patents due to their broad and often abstract nature.[41]

[33] Simonite, 2018
[34] Wang, 2018
[35] European Patent Office, 2019
[36] Spruson and Ferguson, 2019
[37] Clark et al. 2019
[38] Lee, 2013
[39] Leahy-Smith America Invents Act, 2011
[40] Alice Corp. v. CLS Bank International, 2014
[41] Bessen, 2013

Box 2: Challenges Comparing Patent Filings: The US and China

China has outpaced the US in new patent applications related to the machine learning subfield of deep learning.[42] While some observers have interpreted this information as evidence of China's fast approaching superiority over the US in new AI innovation, three key pieces of information about China and the US's patent systems should make us view these statistics in a different light.

First, patents in the US and China have very different standards, requirements and protections. The majority of technology patents in China are filed as "utility patents," a category of patent in China not extant in the US.[43] Utility patents require a smaller inventive step, are subject to less rigorous examination upon filing, and last only 10 years (in comparison to 21 years for American patents). Consequently, this has led to filers taking advantage of lax inspections and review. In a 2018 report, the Chinese state-owned Xinhua News Agency accused China's IP system of being characterized by "weak IP, fake demands and some companies fervent on phony innovation," according to a translation by Bloomberg News.[44] Chinese "invention patents" have requirements more similar to those in the US and last for 20 years rather than 10. However, they only comprise 23% of patent holdings in China.

Second, in China, there are strong government financial incentives for researchers to file patents, regardless of the underlying patents' merit.[45] This is particularly true in AI, where the Chinese central government has committed substantial public funds to encourage inventions.

Finally, it is important to look at the "discard rate" for Chinese patents—i.e. how quickly a patent is discarded by its holder—and how they compare to patents in the United States. A substantial percentage of Chinese patent holders allow their patents to expire before the patent's lifespan is complete—61% for utility patents and 37% for invention patents—in comparison to a discard rate of 15% in the US.[46] When viewed in context with the previous points, it becomes clear that there are many Chinese researchers who file for AI patents in order to claim government incentives without genuinely believing their invention is notable.[47]

Regulating National-Security-Related IP Access

Countries' patent regimes for AI are not only shaped by economic motivations, but also by national security interests. National governments typically pursue two primary interests on this front: to ensure that their own national security apparatuses have access to state-of-the-art technology, and to withhold that access from perceived rivals.

On the goal of ensuring access, a US court decision in 2015 held that the federal government can use patented inventions without the permission of the patent holder and cannot be forced to cease usage of a patented

[42] Huang, 2018
[43] Chen, 2018
[44] Ibid.
[45] Ibid.
[46] Ibid.
[47] Ibid.

invention; the only remedy is for the patent holder to request damages assessed at market rate (which amounts to compulsory licensing).[48] This means if a patent holder does not wish for their patent to be used by the government (e.g. a patent that has potential surveillance applications) their only recourse after suing for infringement is to force the government to pay for a reasonably costed license. This process is quite distinct from what happens when a private entity infringes on a patent, where the private entity can be enjoined to cease usage of the patent or be assigned additional damages.

Additionally, over the last few years the Chinese government has passed broad laws on national security and cybersecurity with implications for access to intellectual property.[49] One of these laws mandates that network operators (broadly defined) provide "technical support and assistance" to national security relevant government offices.[50] The exact legal authority of the Chinese government to force cooperation with Chinese companies is difficult to know. The Center for a New American Security's Ashley Feng reports that "U.S. government officials, including at the FBI, interpreted this vague language to mean that all Chinese companies, including Huawei, are subject to the direct orders of the Chinese government."[51] However, The Diplomat's Jack Wagner reports that the main purpose of the law is to mandate additional data localization and storage on Chinese mainland servers and to set standards around cybersecurity.[52] Additional concerns around Chinese corporations acting as extensions of the state are conceivable, but more speculative in nature.

On the goal of withholding access from perceived rivals, the US and the UK have long had government statutes that empower their patent offices to prevent public disclosure and bar the award of patents that have national security implications, regardless of their other merits.[53] In the US in 2018, 5,792 patent applications were covered within these so-called "secrecy orders," higher than at any point since the Cold War.[54]

[48] Astornet Technologies Inc. v. BAE Systems, Inc, 2015
[49] Feng, 2019
[50] Ibid.
[51] Ibid.
[52] Wagner, 2017
[53] Schulz, 2013; Marks, 2010
[54] Patent and Trademark Office, 2018

4. Three Scenarios for the Future of AI Intellectual Property Strategies

Given the observed corporate AI developer IP strategies and growing government interest in IP law as a lever for influencing AI development, how could the dynamics of AI intellectual property protection evolve? What would these dynamics then mean for the future of the AI industry, and in particular, on the competitive strategies employed by firms and states?

Here we present three plausible scenarios which focus on how the IP strategies of corporate AI developers could evolve in the near future:

(1) Open Research Continues: The status quo persists: open research alongside defensive patents remains the norm within the ML industry.
(2) Patent Lawsuits and Secrecy: Offensive patent litigation breaks out within the ML community and prompts additional secrecy among developers.
(3) Expansion of Patent Pools: In response to the threat of litigation, AI developers enter into additional patent sharing agreements.

In the following section, we describe each scenario and present evidence to support its plausibleness. These scenarios are intended to be illustrative rather than predictive; indeed, there are several alternative and hybrid scenarios that could warrant further investigation as well.

Path #1: Open Research Continues

Scenario:
Each of the major AI developers weighs the costs of engaging in patent litigation against their competitors, and decides that the threat of a countersuit and the symmetrical legal costs make litigation a poor choice. Each developer continues to file for patents in order to maintain a credible response, but analogous to a nuclear standoff, this "mutually assured destruction" framework holds.

This equilibrium is bolstered by competition for researchers who want to work at companies that prioritize openness and cooperation with their peers. Some patent trolls—firms that profit from licensing and litigating on patents without producing any products of their own—may gain control of patents and engage in litigation without fear of reprisal, but these lawsuits remain relatively insignificant.

Evidence in Favor:

- Despite the recent flurry of activity on the subject, the machine learning community currently shows little sign of changing its open and non-litigious culture. Academics and individuals around the world can use cutting edge machine learning techniques from open-source platforms free of charge. There has

been some litigation over trade secret theft in autonomous vehicles (Waymo vs. Uber,[55] Baidu vs. JingChi[56]), but no large-scale patent litigation over broad concepts in machine learning.

- Current patent rules in the US make AI-related software patents less threatening for the purposes of litigation than they were before the Supreme Court's 2014 decision in *Alice Corp. v. CLS Bank International*, which made software patents more likely to be classified as "abstract ideas" and thus unpatentable. Given this decision, it is likely that many existing AI patents, particularly those covering broad mathematical concepts, will be rejected during litigation or at the Patent Trial and Appeal Board.
- While some AI-related patents in the US are being granted, the majority are not. Data from patent filings shows that in recent years, over 90% of AI-related patent applications in the US were initially rejected, many for being merely "abstract ideas" that are not eligible for patentability.[57] By comparison, the overall rejection rate for patents in the US is 48%.[58] Fewer AI-related patents mean fewer opportunities for companies to litigate over infringement, thus bolstering the incentives for open research.
- If large tech companies choose to litigate with one another over AI-related IP, they do not just have to contend with a defendant's AI-related patents, but also with all of the other patents that would likely be used in a countersuit.[59] Google, Microsoft, Amazon, and IBM have expansive business operations across several verticals; this makes patent aggression with other large companies less attractive.

Path #2: Patent Lawsuits and Secrecy

Scenario:
Major patent litigations break out between AI developers. While the previous open equilibrium may be preferable for the collective interest of major private AI developers, it may only take one large company deciding it is in its interest to pursue active litigation for this state of affairs to deteriorate. For instance, if IBM, with its trove of AI-related patents and its struggling core enterprise business,[60] chose to litigate against its rivals, it could provoke additional litigation. So-called "patent trolls" (entities that accumulate patents while not producing products of their own) could also threaten to disrupt the mutually assured destruction equilibrium and engage in lawsuits without fear of reprisal. This litigation could bleed over and affect academic research. While the EU has a research exemption that protects academic use from being deemed infringement, the US has no such exemption, and university researchers could thus potentially find themselves on the wrong end of litigation.[61]

As litigation escalates, there is a substantial incentive for companies to ensure that potentially patentable inventions are kept secret from rivals. In a 2017 paper, Nick Bostrom discusses how the pursuit of patents in AI

[55] Korosec, 2018
[56] Borak, 2017
[57] Decker, 2019
[58] Carley et al. 2015
[59] For example, if Google were to engage in litigation against another company over machine learning patents, they would have to contend with its opposition's patents in E-commerce, search, drones, self-driving cars, smartphone hardware and software and telecommunications, because each of these are areas in which Google operates in and is thus capable of infringement.
[60] Imbert, 2018
[61] Miller, 2002

could cause companies to share research less often in order to prevent other entities from using intermediary research to obtain a patent first.[62] Public research could also be used as evidence in litigation to prove infringement (e.g. releasing a model using a patented method), further dissuading companies in a litigious environment from engaging in open-source communities.

Evidence in Favor:

- As discussed previously, governments in the US, China, EU, and elsewhere are pushing to broaden the scope of patentable material in AI and encourage filings. If these efforts translate into more ostensibly defensible AI patents being filed successfully, this could increase incentives for litigation between patent-holders.
- While Google reported that it is holding new AI patents on a defensive basis, other developers have been non-committal about their future intention to litigate with their patents.[63] When asked about the issue, a Facebook spokesperson said that "its filings shouldn't be read to indicate current or future plans."[64] IBM's patent counsel released a statement that said its large AI patent portfolio "reflects its commitment to fundamental research."[65]

Path #3: Expansion of Patent Pools

Scenario:
AI developers agree to cross-license their patents to one another in a "pool" to reduce the risk of litigation. We previously discussed patent sharing agreements in the context of companies like Google and Tencent using these deals to gain market entry into new countries. However, patent sharing agreements need not only be between two actors. There are several historical examples of large technology companies pooling their patents to protect against litigation and create advantageous licensing dynamics. The DVD6C Licensing Group was comprised of eight of the most high profile patent holders in DVD technology (including Samsung and Toshiba, among others).[66] Third-party manufacturers interested in using their technology could approach the group as a one-stop clearinghouse in order to obtain licenses instead of approaching each member individually. Similar arrangements would enable companies within the pool to share trade secrets and research and development, though too much coordination would come under the ire of antitrust enforcement.

In this scenario, patent pools could be used not only to curtail litigation risks, but also to limit or promote certain applications of AI. As previously mentioned, companies are currently able to individually place stipulations on patent licensing. If a company decided that it wanted to refuse to license its patents to manufacturers of, for example, autonomous weapons, on moral grounds, it could certainly do so.

Extending this to a patent pool, corporate AI developers could group together to share intellectual property and establish shared standards for how they wish to have their intellectual property used, perhaps based on certain

[62] Bostrom, 2017
[63] Simonite, 2018
[64] Ibid.
[65] Ibid.
[66] DVS6C Licensing Group

ethical principles. These standards could then be implemented via, for example, selective licensing agreements which restrict use of the pool's IP to actors who commit to abiding by those standards. Membership of the patent pool could also be made conditional on abiding by the pool's standards. Indeed, patent pools used for licensing agreements by standard setting bodies such as the International Standards Organization are precedent for similar structures' success. It is worth noting, however, that such multilateral "refusals to deal" would need to be implemented with caution and appropriate due diligence in order to avoid potential infringements of antitrust law.[67]

Evidence in Favor:

- Existing software patent pools show the demand for and utility of this type of coordination. Google and several other tech companies participate in the Open Invention Network and Android Networked Cross-License Agreement in order to protect Linux and Android developers from infringement litigation.[68] As an alternative, the MPEG LA group is an example of a software patent pool that operates as a profitable licensing association for its members.[69] Facebook and Google's aforementioned existing patent non-aggression agreements could also be a path towards greater cooperation.
- Increasing returns to scale in AI (meaning that more data improves AI systems and platforms, which attracts more users, which in turn generates more data) could increase the odds of industry centralization. A smaller number of relevant actors improves the feasibility of this kind of coordination.

[67] Department of Justice
[68] Open Invention Network, 2017
[69] MPEG LA

5. Conclusion

AI is poised to be a critically impactful technology, and its development will be deeply affected by existing social and legal institutions. This paper has preliminarily explored an under-examined aspect of this infrastructure: the legal rules, norms, and strategies governing AI-related intellectual property.

Leading corporate AI developers today have employed a dynamic and at times unintuitive IP strategy that allows them to respond to the shifting competitive landscape surrounding them. Governments are also seeking to shape IP systems that incentivize innovation around AI while also protecting their national security interests. How each actor balances its varying objectives in relation to AI and how they choose to wield IP strategies to achieve these objectives remains to be seen.

This preliminary analysis scratches the surface of what may be an important element of the strategic landscape shaping competition and cooperation among AI firms and prominent national governments. Further investigation in this direction could be fruitful for better understanding the goals and strategies of actors seeking to protect AI-related intellectual property, and how these strategies have flow-on implications on the competitive dynamics that arise between AI developers. This, in turn, could shed light on questions related to the prospects for cooperation between these actors to achieve prosocial outcomes with respect to AI ethics and safety, and more broadly, the appropriate governance of AI going forward.

References

Agreement on Trade-Related Aspects of Intellectual Property Rights. 1 Jan. 1995, https://www.wto.org/english/docs_e/legal_e/27-trips.pdf. Accessed 12 Apr. 2019.

Alice Corp v. CLS Bank International. 19 June 2014, https://www.supremecourt.gov/opinions/13pdf/13-298_7lh8.pdf. Accessed 12 Apr. 2019.

Amazon Web Services. "Amazon Rekognition." https://aws.amazon.com/rekognition/. Accessed 7 Nov. 2019.

Amazon Web Services. "Open Source at AWS." https://aws.amazon.com/opensource/. Accessed 12 Apr. 2019.

Apple. "Legal Contact/Patent." https://www.apple.com/legal/contact/patent.html. Accessed 12 Apr. 2019.

Astornet Technologies Inc. v. BAE Systems, Inc. 19 Sept. 2015, http://www.cafc.uscourts.gov/sites/default/files/opinions-orders/14-1854.Opinion.9-15-2015.1.PDF. Accessed 12 Apr. 2019.

Baidu. "Github/OpenEdge." https://github.com/baidu/openedge. Accessed 12 Apr. 2019.

Bessen, James. "The patent troll crisis is really a software patent crisis." *Washington Post*, 3 Sept. 2013, https://www.washingtonpost.com/news/the-switch/wp/2013/09/03/the-patent-troll-crisis-is-really-a-software-patent-crisis/. Accessed 12 Apr. 2019.

Borak, Masha. "Baidu sues its former SVP for stealing self-driving trade-secrets and using them in his US-based startup." *TechNode*, 22 Dec. 2017, https://technode.com/2017/12/22/baidu-sues-former-svp-stealing-self-driving-trade-secrets-using-us-based-startup/. Accessed 12 Apr. 2019.

Bostrom, Nick. "Strategic Implications of Openness in AI Development." *Global Policy*, 2017, https://nickbostrom.com/papers/openness.pdf. Accessed 12 Apr. 2019.

Cadell, Cate. "Google announces patent agreement with Tencent amid China push." *Reuters*, 18 Jan. 2018, https://www.reuters.com/article/us-china-google-tencent/google-announces-patent-agreement-with-tencent-amid-china-push-idUSKBN1F80DF. Accessed 12 Apr. 2019.

Cai, Fangyu. "Tencent Open-Sources its Massive Multi-Labeled Image Dataset." 10 Sept. 2018, https://medium.com/syncedreview/tencent-open-sources-its-massive-multi-labeled-image-dataset-7b0b3dd5373f. Accessed 12 Apr. 2019.

Carley, Michael, Deepak Hegde, and Alan Marco. "What is the probability of receiving a US patent?" *Yale Journal of Law and Technology*, 2015.

Chen, Lulu YiLun. "China Claims More Patents Than Any Country–Most Aare Worthless." *Bloomberg*, 26 Sept. 2018,

https://www.bloomberg.com/news/articles/2018-09-26/china-claims-more-patents-than-any-country-most-are-worthless. Accessed 12 April 2019.

Clark, Alex, Ella Hollowood, Imogen Harper, and Alexi Mostrous. "AI in the UK." *Tortoise Media*, 4 Dec. 2019, https://members.tortoisemedia.com/2019/12/04/ai-in-the-uk/content.html. Accessed 16 Jan. 2020.

Clark, Jack. "Apple's Deep Learning Curve." *Bloomberg*, 29 Oct. 2015, https://www.bloomberg.com/news/articles/2015-10-29/apple-s-secrecy-hurts-its-ai-software-development. Accessed 12 Apr. 2019.

Cohen, Jon. "CRISPR Patent Fight Revived." *Science*, 5 July 2019, https://science.sciencemag.org/content/365/6448/15.2. Accessed 22 Sept. 2019.

Conger, Kate, David E. Sanger, and Scott Shane. "Microsoft Wins Pentagon's $10 Billion JEDI Contract, Thwarting Amazon." *New York Times*, 25 Oct. 2019, https://www.nytimes.com/2019/10/25/technology/dod-jedi-contract.html. Accessed 7 Nov. 2019.

Decker, Susan. "Who Profits from AI? It's Getting Harder to Find Out." *Bloomberg*, 23 Jan. 2019, https://www.bloomberg.com/news/articles/2019-01-23/who-profits-from-ai-uncertain-as-u-s-patent-office-gets-pickier. Accessed 26 Aug. 2019.

Department of Justice. "The Strategic Use of Licensing: Unilateral Refusals to License PatentsDeal." https://www.justice.gov/atr/chapter-1-strategic-use-licensing-unilateral-refusals-license-patents. Accessed 12 Apr. 2019.

Dignan, Larry. "All of Amazon's 2017 operating income comes from AWS." *ZDNet*, 1 Feb. 2018, https://www.zdnet.com/article/all-of-amazons-2017-operating-income-comes-from-aws/. Accessed 12 Aug. 2019.

Duhigg, Charles and Steve Lohr. "The Patent, Used as a Sword." *New York Times*, 7 Oct. 2012, https://www.nytimes.com/2012/10/08/technology/patent-wars-among-tech-giants-can-stifle-competition.html. Accessed 12 Apr. 2019.

Dutton, Tim. "An Overview of National AI Strategies." 28 Jun. 2018, https://medium.com/politics-ai/an-overview-of-national-ai-strategies-2a70ec6edfd. Accessed 12 Apr. 2019.

DVD6C Licensing Group. "DVD6C Patent Pool." http://www.dvd6cla.com/. Accessed 12 Apr. 2019.

European Patent Office. "Guidelines for Examination." https://www.epo.org/law-practice/legal-texts/html/guidelines2018/e/g_ii_3_3_1.htm. Accessed 12 Apr. 2019.

Feng, Ashley. "We Can't Tell if Chinese Firms Work for the Party." *CNAS*, 7 Feb. 2019, https://www.cnas.org/publications/commentary/we-cant-tell-if-chinese-firms-work-for-the-party. Accessed 12 Apr. 2019.

Ford, Martin R. *Architects of Intelligence: the truth about AI from the people building it*. Packt, 2018.

Google. “Patents in the Service of Open Source.” https://www.google.com/patents/opnpledge/. Accessed 12 Apr. 2019.

Google. “Introducing PAX: the Android Networked Cross-License Agreement.” 3 Apr. 2017, https://blog.google/topics/public-policy/introducing-pax-android-networked-cross-license-agreement/. Accessed 7 Nov. 2019.

Griswold, Alison. “Amazon Web Services brought in more money than McDonald’s in 2018.” *Quartz*, 1 Feb. 2019, https://qz.com/1539546/amazon-web-services-brought-in-more-money-than-mcdonalds-in-2018/. Accessed 7 Nov. 2019.

Gurman, Mark. “Apple Warns Employees to Stop Leaking Information to the Media.” *Bloomberg*, 13 Apr. 2013, https://www.bloomberg.com/news/articles/2018-04-13/apple-warns-employees-to-stop-leaking-information-to-media. Accessed 12 Apr. 2019.

Hardy, Quentin. “Google Buys Motorola For Patent Parts.” *Forbes*, 15 Aug. 2011, https://www.forbes.com/sites/quentinhardy/2011/08/15/google-buys-motorola-for-patent-parts/#17555b562fff. Accessed 12 Apr. 2019.

Huang, Echo. “China has shot far ahead of the US on deep-earning patents.” *Quartz*, 2 Mar. 2018, https://qz.com/1217798/china-has-shot-far-ahead-of-the-us-on-ai-patents/. Accessed 26 Aug. 2019.

IBM. “IBM and NVIDIA Collaborate to Expand Open Source Machine Learning Tools for Data Scientists.” 10 Oct. 2018, https://newsroom.ibm.com/2018-10-10-IBM-and-NVIDIA-Collaborate-to-Expand-Open-Source-Machine-Learning-Tools-for-Data-Scientists. Accessed 12 Apr. 2019.

Imbert, Fred. “Sell IBM shares because its profits are in an ‘irreversible structural decline,’ analyst says.” *CNBC*, 4 Oct. 2018, https://www.cnbc.com/2018/10/04/ibm-profits-are-in-an-irreversible-structural-decline-analyst-says.html. Accessed 22 Sept. 2019.

Korosec, Kirsten. “Waymo V. Uber: What You Need to Know About the High-Stakes Self-Driving Tech Trial.” *Fortune*, 5 Feb. 2018, http://fortune.com/2018/02/05/waymo-v-uber-what-you-need-to-know-about-the-high-stakes-self-driving-tech-trial/. Accessed 12 Apr. 2019.

Leahy-Smith America Invents Act. 16 Sept. 2011, https://www.uspto.gov/sites/default/files/aia_implementation/20110916-pub-l112-29.pdf. Accessed 12 Apr. 2019.

Lee, Timothy B. “Here’s why economists hate software patents.” *Washington Post*, 31 July 2013, https://www.washingtonpost.com/news/the-switch/wp/2013/07/31/heres-why-economists-hate-software-patents/. Accessed 7 Nov. 2019.

Leswing, Kif. “Apple is now publishing a ‘journal’ with its cutting-edge machine learning research.” *Business Insider*, 19 July 2017, https://www.businessinsider.com/apple-announces-apple-machine-learning-journal-2017-7. Accessed 12 Apr. 2019.

Marks, Paul. “UK keeps three times as many patents secret as the US.” *New Scientist*, 23 Mar. 2010, https://www.newscientist.com/article/dn18691-uk-keeps-three-times-as-many-patents-secret-as-the-us/. Accessed 12 Apr. 2019.

Microsoft. “Annual Report 2018.” 16 Oct. 2018. https://www.microsoft.com/en-us/annualreports/ar2018/annualreport. Accessed 7 Nov. 2019.

Microsoft. “Azure IP Advantage.” https://azure.microsoft.com/en-us/overview/azure-ip-advantage/. Accessed 12 Apr. 2019.

Microsoft. “Discover more options with open source on Azure.” https://azure.microsoft.com/en-us/overview/choose-azure-opensource/.

Microsoft. “Microsoft to acquire Github for $7.5 Billion.” 4 June 2018, https://news.microsoft.com/2018/06/04/microsoft-to-acquire-github-for-7-5-billion/. Accessed 12 Apr. 2019.

Miller, Jennifer. “Sealing the Coffin on the Experimental Use Exception.” 2002, https://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=1081&context=dltr. Accessed 12 Apr. 2019.

MPEG LA. https://www.mpegla.com/. Accessed 7 Nov. 2019.

Novet, Jordan. “Google says its cloud now brings in $1 billion per quarter.” *CNBC*, 1 Feb. 2018, https://www.cnbc.com/2018/02/01/google-cloud-revenue-passes-1-billion-per-quarter.html. Accessed 7 Nov. 2019.

Open Invention Network. https://www.openinventionnetwork.com/. Accessed 7 Nov. 2019.

Patent and Trademark Office. “Invention Secrecy Activity.” https://fas.org/sgp/othergov/invention/stats.html. Accessed 12 Apr. 2019.

Peterson, Becky. “IBM's $34 billion Red Hat acquisition came after deal talks with Microsoft, Google, and Amazon, sources say.” *Business Insider*, 16 Dec. 2018, https://www.businessinsider.com/red-hat-deal-talks-with-amazon-microsoft-google-before-34-billion-ibm-acquisition-2018-12. Accessed 12 Apr. 2019.

Quinn, Gene. “Google: We Don’t Sell to Patent Trolls.” *IPWatchdog*, 2 May 2013, http://www.ipwatchdog.com/2013/05/02/google-we-dont-sell-to-patent-trolls/id=39927/. Accessed 12 Apr. 2019.

Regalado, Anthony. “Google’s Growing Patent Stockpile.” *MIT Technology Review*, 29 Nov 2013, https://www.technologyreview.com/s/521946/googles-growing-patent-stockpile/. Accessed 26 Aug. 2019.

Schulz, G.W. “Government Secrecy Order on Patents Have Stifled More Than 5,000 Inventions.” *Wired*, 16 Apr. 2013, https://www.wired.com/2013/04/gov-secrecy-orders-on-patents/. Accessed 12 Apr. 2019.

Simonite, Tom. “Despite Pledging Openness, Companies Rush to Patent AI Tech.” *Wired*, 31 July 2018, https://www.wired.com/story/despite-pledging-openness-companies-rush-to-patent-ai-tech/. Accessed 12 Apr. 2019.

Spruson and Ferguson, “Singapore Update: IPOS Grants First Accelerated Patent Under Fintech Fast Track Initiative.” 14 Dec. 2018, https://www.spruson.com/fintech/singapore-update-ipos-grants-first-accelerated-patent-fintech-fast-track-initiative/. Accessed 12 Apr. 2019.

Stone, Brad and Ashlee Vance. “Apple’s Obsession With Secrecy Grows Stronger.” *New York Times*, 22 June 2009, https://www.nytimes.com/2009/06/23/technology/23apple.html.

TensorFlow. “An end-to-end open-source machine learning platform.” https://www.tensorflow.org/. Accessed 12 Apr. 2019.

United States Patent and Trademark Office. “USPTO Fee Schedule.” https://www.uspto.gov/learning-and-resources/fees-and-payment/uspto-fee-schedule#Patent%20Maintenance%20Fee. Accessed 26 Aug. 2019.

Wagner, Jack. “China’s Cybersecurity Law: What You Need to Know.” *The Diplomat*, 1 June 2017, https://thediplomat.com/2017/06/chinas-cybersecurity-law-what-you-need-to-know/.

Wang, Qian. “Global Perspectives: AI and IP Policies Around the World.” *Artificial Intelligence: Intellectual Property Considerations*, 31 Jan. 2018. Presentation.

Webb, Michael, Nicholas Bloom, Nick Short, and Josh Lerner. “Some Facts of High Tech Patenting.” *Harvard Business School*, July 2018, https://www.hbs.edu/faculty/Publication%20Files/19-014_cf3bccb7-1ab7-4f43-b822-2d7c9b04a2c0.pdf. Accessed 12 Apr. 2019.

Wolff, Adam. “Relicensing React, Jest, Flow, and Immutable.js.” *Facebook*, 22 Sept. 2017, https://code.fb.com/web/relicensing-react-jest-flow-and-immutable-js/. Accessed 12 Apr. 2019.

World Economic Forum. “Artificial Intelligence Collides with Patent Law.” Apr. 2018, http://www3.weforum.org/docs/WEF_48540_WP_End_of_Innovation_Protecting_Patent_Law.pdf. Accessed 26 Aug. 2019.

World International Patent Organization. “Protecting yYour Inventions Abroad: Frequently Asked Questions About the Patent Cooperation Treaty.” Oct. 2017, https://www.wipo.int/pct/en/faqs/faqs.html. Accessed 12 Apr. 2019.

World International Patent Organization. “What is Intellectual Property?” https://www.wipo.int/about-ip/en/. Accessed 7 Nov. 2019.