Getting the Innovation Ecosystem Ready for AI

An IP policy toolkit

WIPO

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World Intellectual Property Organization
34, chemin des Colombettes, P.O. Box 18
CH-1211 Geneva 20, Switzerland

wipo.int

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Foreword

AI is changing how we work, learn and communicate, delivering breathtaking advances seemingly every other day. Take the AI tool GNoME which identified 2.2 million new crystals, including 380,000 stable materials, that could improve technologies like computer chips, batteries and solar panels.[1] This AI-driven research represents an order-of-magnitude expansion in the stable materials known to humanity and is just one example of how AI can drive scientific discovery and innovation.

Trends in AI patenting also reinforce the sense that we are moving with speed. While digital technology patent applications have grown 170 percent faster than average over the past five years, AI growth is over 700 percent.[2] Generative AI, which has captured headlines around the world, now numbers more than one in five of AI-related patents, and this number is rising quickly.[3]

As a UN agency, we believe that the immense capacity of AI for transformation should be driven towards making our world a better place for all. From precision agriculture capable of optimizing crop yields to new ways of predicting disease outbreaks, optimizing water management and modeling climate change, AI can and should catalyze the innovations that will help us get the 2030 sustainable development goals back on track.

Against this complex backdrop, policymakers have to grapple with multifaceted and sometimes novel issues presented by AI to the IP ecosystem as they attempt to balance competing interests whilst supporting innovation, and ultimately find the best way forward that will serve the country's political, economic and social needs.

We hope that this guide will help policymakers to navigate these uncharted waters and find their own way forward that will not only serve their country but also build a global ecosystem where AI innovations benefit us all.

Daren Tang
Director General, World Intellectual Property Organization

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Introduction

AI technologies are evolving at an exponential pace. Advances in AI models, especially large language models and generative AI, are revolutionizing many areas, including the innovation space. AI innovations, from smart agriculture solutions and modeling climate change to AI for health and education, hold one of the keys to addressing some of the most pressing global issues.

The development and training of AI models can represent a significant investment, including human capital, computer processing power and electricity. Some estimate that the cost of training the next generation of large language models will pass USD 1 billion within a few years.

The ability of these new models to combine data sets and produce insights is driving the development of new products and processes that incorporate AI, such as agribots that assist pollination in greenhouses where bees are overwhelmed by the scale of the task, hand-held smart devices that provide speech to sign language translation, or AI-driven supply chain and logistics processes.

AI is also being used by human innovators as a highly effective tool, for example, to help identify potential new drug candidates or assist in engineering design.

AI innovation is at the core of all these examples: AI models, AI-based products and processes, and the use of AI as an innovation tool. Intellectual property (IP) is a key lever that can be used by policymakers to shape appropriate innovation ecosystems and to help them foster AI innovation.

However, AI raises many questions and challenges for IP and the IP system, right now and in the future, as AI becomes more autonomous and has the potential to change the innovation process. The purpose of this IP toolkit is to provide policymakers with a framework to understand the state of play of AI innovation right now and to think about the future of AI becoming increasingly autonomous.

The toolkit starts with an AI primer to help policymakers understand some of the basic principles of AI technology, where it is right now and what may be expected in the future.

Part 2 considers the many challenges innovators in the AI space face right now as they are exploring how to make the best use of IP to protect their ideas and investments. This toolkit seeks to assist policymakers by providing them with a framework for differentiating types of AI innovations, identifying the related IP questions and suggesting actions policymakers could take to shape their ecosystems or to provide guidance to innovators.

As AI is becoming more autonomous, policymakers will have to consider when AI may be considered as an inventor under IP law. Part 3 dives into some of the considerations that policymakers may find useful to assess whether AI innovation has entered a new phase.

Should AI become capable of invention autonomously, Part 4 sets out some of the options that policymakers could consider, including the pros and cons of the different choices and the potential ripple effects on the IP legal framework.

Overall, this IP policy toolkit is intended to allow policymakers to engage in the topic of how to best shape their AI innovation ecosystem and to structure their future work with a firm understanding of the current state of knowledge.

1 / AI primer

What is AI?

Artificial intelligence (AI) refers to the branch of computer science and engineering that focuses on creating systems capable of performing tasks that typically require human intelligence. These tasks include understanding natural language, recognizing images, making decisions and learning from data.

Machine learning (ML) is a subset of AI that specializes in developing algorithms and models, allowing computers to learn from data and improve their performance on specific tasks without explicit programming. AI and ML are often used interchangeably since the most advanced AI systems are based on ML algorithms.

Within AI, the term “architecture” generally describes the overall design or general framework of an AI system. The AI algorithm is the set of instructions guiding the AI system to learn from data to perform a specific task. The term “AI model” refers to a specific implementation of an algorithm trained on data.

> In an AI system, the architecture provides the framework, the algorithm defines task execution and the model is a data set-trained implementation of the algorithm.

AI has a rich and complex history, emerging as an academic discipline in the mid-20th century. Early efforts focused on symbolic AI, which aimed to create intelligent systems using rule-based reasoning. An example of this is: “When it rains, remind the user to bring an umbrella.” This approach had limited success. Life is simply too complex to list all possible rules. Initial advancements were made in problem-solving, logical reasoning and game-playing programs before this approach reached its limitations (sometimes referred to as the first “AI winter”).

The 1990s witnessed the rise of statistical methods, such as ML. This quickly became the dominant approach, and it remains so to this day. Instead of explicit logic or rule-based reasoning, statistical methods compute probabilities of possible outcomes based on the current input. The system then either chooses the most probable outcome or it samples the outcomes according to their probability, that is, it chooses those outcomes that are more likely to occur.

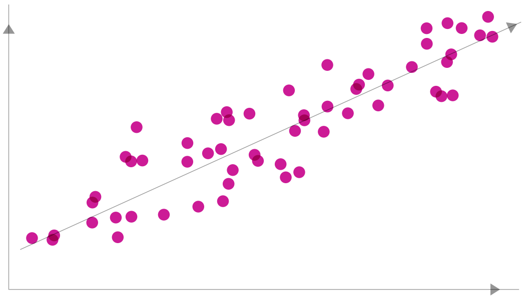
The importance of data

Learning from data

One type of ML is supervised ML, meaning that the algorithm learns from a labeled data set that connects a specific input to a specific output, also known as training data.

The simplest example of an ML algorithm is a linear regression, where the relationship between the input and output is linear. This is similar to plotting a known data set of (x,y) coordinates and finding the closest linear relationship that allows the prediction of further data points (see Figure 1).

Figure 1: **Linear regression**

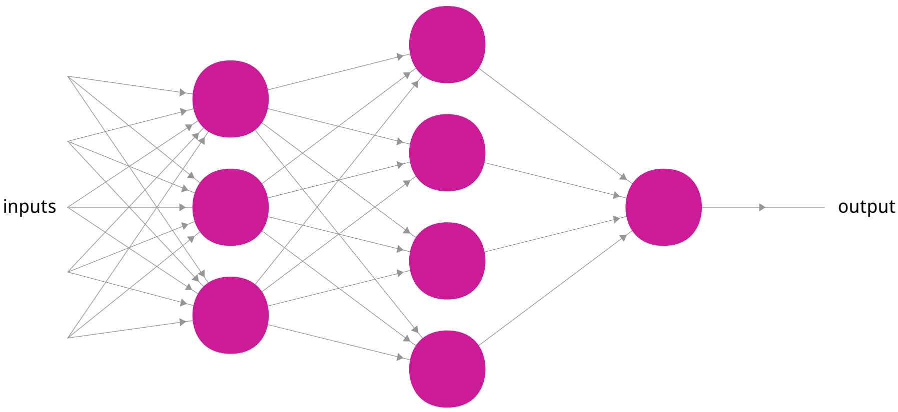


Such a linear regression is often too simple a function to solve ML problems. In essence, many problems cannot be represented by a linear relationship.

So neural networks are used instead. A neural network is a computational model inspired by the human brain. A neural network consists of interconnected nodes, called neurons, organized into layers. So-called deep neural networks are architectures with many, many layers.

The network takes input data, processes it through these layers, and generates the output. Compared to a linear regression, the relationship between the input and the output is more complicated. Every neuron has several adjustable parameters (e.g., weightings) and, by tuning them, many different input–output relationships can be created (see Figure 2). The number of neurons and the structure of the neural network can be chosen to suit the specific problem an algorithm is designed to solve.

Figure 2: **Input–output relationships**



Learning from training data involves adjusting the model's parameters so that when it receives an input it was trained on, it generates an output similar to what it learned for that input. It is important to understand that ML algorithms go beyond simply memorizing a data set. The parameters of the neurons will ultimately allow the network to start predicting a statistically likely output for any input.

The underlying idea is that – provided there are enough labeled data – an ML model will also be able to produce meaningful output for an input that it has never seen. This is similar to a human child who can correctly identify a poodle as a dog even if the child has only seen a labrador and a dachshund. This is what is typically referred to as generalization.

The most important takeaways from this are as follows:

- In neural networks, the relevant parameters are not explicitly programmed into the system but are learned from data.

- The neurons, once assigned a set of parameters, enable the neural network to predict outputs from any given input.
- Such a model is sometimes also referred to as a trained model.

Scale is everything

The current rapid advancements of AI are mostly due to scale. Whereas early ML systems had few parameters and were trained on perhaps a couple of thousand labeled data point examples, today's systems have trillions of parameters.

By comparison, the human brain has less than 100 billion neurons, so only a fraction of the number of parameters being built into current ML models. While the data that human brains access are limited to our general knowledge, for example by what we have read, listened to and learned, current ML models are also trained on essentially all the data that are known to mankind.

This has been made possible by rapid advances in computing and storage. Training a neural network from scratch is a formidable task and often costs hundreds of millions of dollars.[5]

However, once such a neural network has been trained it can be refined to perform well on a specific task. The refinement comes at a much lower cost.

The importance of the model

A crucial component in designing a good ML model is to choose a suitable underlying function. In other words, currently, ML models need to be specifically designed by humans to fit a certain task and then trained with good-quality data sets. Neural networks and deep neural networks are popular choices.

What is generative AI?

The launch of ChatGPT in November 2022 has brought generative AI into the spotlight and to mainstream attention.

Traditional AI systems are primarily used to analyze data and make predictions.

Generative AI goes a step further by being able to create new data similar to its training data. Underlying network architectures are based on methods such as transformers (GPT, for example, stands for generative pre-trained transformer) or GANs (generative adversarial networks). These methods make it possible for generative AI to create new content, including audio, code, images, text, simulations and videos. However, generative AI is not limited to only content generation. Generative AI refers to any ML model capable of dynamically creating output after it has been trained.

Large language models

The most recent advancement in AI is due to models that are particularly well suited to correlating language. In a language, the individual words form a sequence, and the meaning is not only conveyed by the choice of words but crucially also by the relationships between these words. This requires models that are suitable for processing sequences and that can incorporate a sufficiently long memory to meaningfully capture these relationships. One currently popular class of such functions is called transformers and the resulting models are called language models for obvious reasons. Since the current models are very large, they are often referred to as large language models (LLMs).

Language models and LLMs are not confined to human language processing.

That said, language models and LLMs are not at all confined to the processing and generation of human languages such as English. In ML terms, language can refer to any symbols (such as words) that within context (grammar, relationship between the words) can convey meaning. Another example suitable for processing with LLMs is chemistry. Chemical compounds can be described as atoms (symbols) and chemical bonds (context) to convey a molecular structure (meaning).

A vast array of knowledge can be represented as a sequence of suitably chosen tokens. "Language" in a broad sense can capture many areas of knowledge and some abstract relationships that are typically associated with human intelligence. Language models and LLMs therefore have a potentially large breadth of applications including molecular modeling in drug discovery or medical diagnostics.

How do language models work?

On the most basic level, LLMs are extremely simple. Given a context, for example, a text snippet, the LLM outputs the most likely next word. That is all.

The true power of this simple concept emerges when it is applied repeatedly to generate sentences and paragraphs. Imagine starting a few keywords as initial context, for example, "AI, evolution, patents, impact." Invoking the LLM repeatedly, and incorporating any previous output in the current context, may then produce several well-formed paragraphs that describe the impact of the current evolution of AI on patent law.

Emerging trends and what the future may hold

Where we are today

Today's LLMs are excellent at summarizing text, creating computer programs for well-defined tasks, writing poems, holding conversations or finding answers to frequently asked questions. For many such tasks, their performance is on par with or perhaps better than that of humans.

That said, LLMs still have serious shortcomings. Most of all, LLMs have no notion of truth. Asked, for example, to produce the resumé of a specific person, an LLM is likely to generate a plausible-looking piece of text. In fact, it is likely to read so convincingly well that the reader is lured into thinking it is factual information. But the chances are that many of the entries, such as work placements or experience, are pure fiction. The LLM will simply have combined words in the most likely statistical order without any real understanding.

LLMs also have a difficult time with basic arithmetic or simple logical deduction. Further, LLMs have no notion of social norms or ethical behavior and need substantial post-processing of their output to adhere to such norms.

What the future may hold

The seemingly simple idea behind LLMs can have a powerful impact when being driven by scale. First, modern LLMs can process a context of several thousand words rather than a few letters. Second, these models are trained on essentially all the content that is available on the internet.

Over the years, the number of parameters has increased rapidly. By way of illustration, from 2019 to 2023 the number of parameters grew from 1 billion to 1 trillion, a thousand-fold increase. Most interestingly, this increase has led to a surge in capabilities of LLMs that is much greater than linear. New capabilities have emerged recently that only a few years ago seemed unthinkable. ChatGPT is one such example.

Currently, there are no signs that this surge in capabilities of AI and LLMs will subside anytime soon. Quite the contrary.

It stands to reason that the even larger models that are currently in development, perhaps augmented with special computational units and further substantial engineering efforts, will soon eliminate some of the most glaring shortcomings of LLMs.

Overall, LLMs will likely have an impact on human society comparable to some of the major achievements of the past few centuries such as the invention of the steam engine, the discovery of electricity or the invention of transistors.

2 / Current AI inventions and possible actions to support inventors

The spectrum of AI invention

AI is sometimes described as a general-purpose technology, meaning that it is used across all sectors and industries for a multitude of purposes.[6] After all, it is designed to mimic human intelligence, which drives a wide spectrum of innovation. In turn, AI raises many different IP questions, which can seem overwhelmingly complex.

One way to make sense of AI and the questions it raises for IP is to consider AI's role in the invention process and to see where it exists on a spectrum. The different types of AI inventions will raise different issues, giving policymakers a potential set of lenses through which to consider their IP ecosystem and allowing them to focus on addressing uncertainties faced by local innovators.

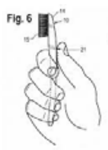
To establish clear and consistent terminology, the following types of AI inventions will be used (see Figure 3):

(a) **AI model:** a new AI model or algorithm.
(b) **AI-assisted invention:** an invention made by humans using AI as a tool, for example, the use of AI to identify a protein-binding site that ultimately leads to the invention of a novel pharmaceutical compound.
(c) **AI-based invention:** an invention that incorporates AI and in which AI forms the basis of the invention, for example, a novel electron microscope that incorporates AI-based image sharpening.[7]
(d) **AI-generated invention:** a future scenario of an invention that was autonomously generated by AI without material human input. Some have alleged that AI can already autonomously generate inventions of its own.

As with other spectrums, like colors in visible light, the boundaries between one category and the next blend at the edges. The same is true here.

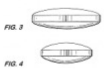
Figure 3: **Examples of AI inventions**

New AI models or algorithms



An AI model to predict the performance of toothbrushes to determine whether they comply with industrial standards.

AI-assisted inventions



The use of AI in drug discovery to select drug candidates.

AI-based inventions

A translation device incorporating AI deep learning.

AI-generated inventions

A future scenario of an invention made autonomously by AI (see DABUS box).

AI models and algorithms

Innovation can occur in AI algorithms and models – with IP playing a pivotal role in fostering and safeguarding these innovations.

Innovations in AI algorithms entail refining existing methodologies or devising entirely new techniques for more accurate, efficient or versatile AI operations. Developing a novel optimization algorithm that accelerates training convergence showcases algorithmic innovation.

Innovations within AI models manifest as enhanced predictive capabilities, improved generalization or the ability to handle more diverse data types. Designing a language model that surpasses previous benchmarks in understanding and generating human-like text showcases model innovation.

These innovations can all require significant investment in their development, prompting questions about protecting this investment by IP, in particular patent rights. The distinction between a mathematical method and a patentable invention can often be ambiguous, mirroring some of the challenges seen in patenting computer software and the need for a technical effect. However, since AI is based on statistical modeling, it is unclear if the principles of patenting computer software apply to AI.[8]

AI-assisted inventions

Inventors may use AI as a tool in the invention process. In these circumstances, AI currently functions like a word processor or drawing tool and the invention is termed an AI-assisted invention.

One way to look at the use of AI as part of the human-driven invention process is to consider the role AI plays in the inventive process, such as optimization, scaling, prediction and screening, diagnosis and monitoring. Despite the advantages brought by AI, the invention process still requires significant human input and experimentation. Once a problem has been identified by a human – for example, to find a molecule to bind to a specific protein-binding site – AI may be faster and more efficient than humans at making an initial selection of possible solutions, subject to receiving human training and orders. However, both the identification of a problem and a solution are done by humans.

Patent law does not generally require an applicant to explain how an invention was made. For example, it is not required to disclose the experiments or physical tools used, the experiments conducted or the thought process of the inventor. The same applies to the use of AI as a tool in the inventive process. Generally, there is no requirement to declare whether AI was used and, if so, how it was used.

Such use of AI as a tool in the inventive process raises IP questions, for instance, regarding patentability, in particular the inventive step requirement.

A related question concerns who made the inventive contribution in cases where AI tools have significantly contributed to the conception of an invention. Possible options include the operator of the AI model who identified a problem and selected an output, the AI model maker or the training data provider.

Furthermore, as AI tools become more and more sophisticated, one can envisage a future scenario where only the identification of a problem is done by a human operator; the identification and selection of a solution is completed by an AI tool. Many jurisdictions do not award patents for the identification of a problem and would exclude such inventions from being patentable.

An example of an AI-assisted invention: drug discovery

AI can design new therapeutic candidates using existing data. Rather than being directed to search for and identify useful assets or information from existing sources, the AI is directed to profile and propose new virtual molecules in silico that do not already exist. One example is Novartis's AI platform called JAEGER, which assists scientists in designing potential new anti-malarial drugs.[9] JAEGER can generate novel virtual molecules, different from any that previously existed but with realistic properties comparable to those in the training set. Using other AI-assisted tools and their intuition, its scientists selected, synthesized and evaluated two of the most promising molecules from the set. They confirmed their strong anti-malarial activity and low cytotoxicity was on par with approved anti-malarial medicines.

Conceptually, JAEGER neither identified a problem nor considered how to address it without prompting from human scientists and modeling from human-made precedents. Nor could it appreciate the properties or utility of its outputs, which had to be further analyzed, synthesized and evaluated by humans before the results were realized. The virtual molecules were generated as an automated response to human prompts and required further human development, synthesis and testing. While JAEGER may have generated what did not exist before, there was no thought process equivalent to conception. Instead, JAEGER is effectively operating as an advanced tool humans use to achieve a human-defined goal in a human-directed innovation process.

AI-based inventions

AI-based inventions represent a fusion of human innovation and AI technology to devise novel processes, products or solutions that incorporate AI as a core component. This integration allows for the creation of innovative solutions that leverage AI's capabilities to achieve technical advancement, for example, an electron microscope engineered with AI capabilities to enhance image clarity or a novel software package for managing customer preferences that includes an AI component. In these scenarios, AI forms an intrinsic part of the invention, based on human ingenuity and advancement.

Patent law requires the disclosure of an invention to be sufficient to allow the invention to become part of the public domain and replicable after patent expiry. When AI forms an integral part of a novel product and service, this raises significant questions. Unlike software, AI is not "linear," and it may be impossible to replicate an AI model without a significant level of detail of the algorithm, architecture and training data.

AI-generated inventions

Some have argued that AI goes beyond being a mere tool in the inventive process. In contrast to a pencil or a microscope, AI can automate aspects of the inventive process that, if performed by a human being, make that person an inventor.[10] In other words, some have argued that AI itself can autonomously generate inventions.

For instance, Dr. Stephen Thaler's Device for the Autonomous Bootstrapping of Unified Sentience (DABUS) system allegedly created prototypes for a beverage holder and emergency light beacon (see DABUS box). While much has been written and argued about it, many computer scientists believe that AI has not yet reached this advanced stage. Undeniably, AI science is advancing at an exponential rate and policymakers should start thinking about potential options available to them to prepare for such a future scenario. Part 4 of this toolkit, therefore, dives into exploring potential future options.

Possible actions for IP offices and policymakers

It is clear that AI innovators currently face many uncertainties. There are a number of actions IP offices and policymakers could contemplate taking to foster an environment conducive to AI innovation.[11]

The effectiveness and appropriateness of these actions will hinge on the desired economic policy direction and the nature and intricacies of the local ecosystem. Therefore, the approach to these actions may involve a nuanced and selective strategy, tailored to align with the unique circumstances and challenges faced by AI innovators in a particular country or region. This section simply aims to suggest some actions that could contribute to a supportive framework for AI innovation.

Provide guidance on IP protection available for the different types of AI inventions

Addressing the challenge of IP protection for all types of AI inventions requires innovators to make an informed choice between copyright and patent protection as well as trade secret protection. Contractual terms and technical protection measures may also provide protection in certain circumstances.

IP offices could consider providing scenarios showcasing the different protection mechanisms and their interplay to empower innovators to make informed decisions that align with the distinct attributes of their AI inventions.

Provide guidance for the patentability of AI models

Patent protection requires that an invention demonstrates a technical effect and is generally not available for mathematical methods. Innovators need to understand if (and when) patent protection is available and how to demonstrate a sufficient technical effect.

AI models are often considered similar to computer programs in this regard. However, the case law for patenting computer programs can be complex to navigate and it is unclear whether this case law should apply to AI models due to their statistical nature.[12]

IP offices could consider providing guidance, including the existing case law for patenting computer programs and how this may apply to AI models. Such guidance that considers the unique attributes of AI models while building upon established precedents would provide direction, instill a sense of assurance in AI innovators and establish a robust foundation for AI models.

Balance data access and data protection and provide relevant guidance to AI model makers

All AI needs to be trained by large amounts of data. Therefore, AI model makers require access to large amounts of training data, often from external sources. These data can also include protected copyright works; copyright owners have a legitimate interest in restricting unauthorized access to their works. AI innovation will require balancing these interests.

Policymakers may want to consider how to balance data access and protection of existing IP rights, taking into account their IP ecosystem and the main economic drivers they are seeking to put in place.

Possible actions policymakers could take to foster AI innovation include:

- providing guidance on the applicability of text and data mining and fair use provisions;
- making available sample data access agreements; and
- providing a sandbox setting, that is, a controlled environment to test and evaluate different scenarios.

Clarify the inventive step requirement for AI-assisted inventions

One of the patentability requirements for AI-assisted inventions is that the invention is not obvious. The evaluation of the inventive step requirement hinges on the expertise of a person skilled in the art; establishing the precise extent of knowledge and skill attributed to this hypothetical individual is pivotal. This requisite knowledge and skill level must be tailored to the specifics of each distinct case. As the integration of AI as a tool in diverse technological domains expands, the utilization of such tools in research by a person skilled in the art might diminish the inventiveness of such applications. Similarly, this rationale extends to the concept of common general knowledge. As AI tools are becoming more sophisticated and AI development is continuing to speed up, many tasks that would have been inventive for humans may become routine for AI.

IP offices could consider providing guidance on the inventive step requirement for AI-assisted inventions. Such guidance could include case examples and showcase the different human players and their (inventive) contributions.

Provide guidance on the different players in the AI ecosystem and how to identify who has made an inventive contribution

AI innovations – irrespective of whether they are AI models, AI-assisted inventions, AI-based inventions or AI-generated inventions – are often multi-contributor. The contributors include data providers, data scrubbers, AI architects and model makers, owners of training data sets, AI operators and more. AI can represent an off-the-shelf solution that is incorporated in products similar to a standard screw or it can be highly specific and custom built for a particular purpose.

IP offices and policymakers may want to identify the different players in the AI ecosystem and the general contributions they make. Such a mapping could then be used to feed into guiding principles identifying which players made an inventive contribution in each case and when multiple players may be considered as joint inventors.[13]

Consider creating a best practice for AI-assisted inventions to record (and disclose) the use of an AI tool

Patent law generally does not require inventors to disclose how an invention was made.

However, the use of AI tools is changing the human contribution and raising questions about the inventive step requirement for AI-assisted inventions.

Policymakers could consider whether to recommend that innovators document and keep internal records about their use of AI tools. This could include the type of AI tools and training data used, or a description of how the output of the algorithm and the human input, selection and processing contributed to the patented AI-assisted invention. These records may assist innovators during the prosecution of their patent or in case there are later challenges to it.

Policymakers may also consider whether to require disclosure of the use of AI tools during the patent prosecution process for AI-assisted inventions. On the one hand, such disclosure might benefit the patent prosecution record and provide more transparency. Such disclosure could, for example, include a detailed narrative explaining the extent to which the AI tool contributed to the making of the invention.[14] On the other hand, not requiring applicants to explain AI contributions to inventions claimed in patent applications avoids some difficulties. An invention made with a hammer is not subject to a separate disclosure regime *vis-à-vis* an invention made with a screwdriver. Requiring applicants to disclose AI contributions introduces incongruity with other tools. Disclosure requirements could also make it more demanding and burdensome to prepare and prosecute patent applications. When joint inventors apply for a patent, there is no requirement for the joint inventors named on the application to identify the specific contributions each made to the claimed subject matter. There is no reason to change this practice when the inventors used AI to make the invention. Finally, examiners may find assessing the significance of AI contribution challenging and subjective. They must assess the underlying technology and the AI, which may differ entirely from the underlying technology. Doing so may artificially magnify the relative importance of AI contributions over the actual invention.

Provide guidance on how to comply with the sufficiency of disclosure requirement for AI-based inventions

Patent applicants are required to sufficiently disclose their invention in their patent application to allow third parties to replicate the invention after patent expiry (the sufficiency of disclosure requirement).

For AI-based inventions that incorporate AI as part of a novel product or process, patent applicants face a real conundrum. They must decide how much of the AI model and training data needs to be disclosed in the patent specification (and in what form) to fulfill this sufficiency of disclosure requirement and safeguard their patent rights from later invalidation attacks.

Examples and guidance by national IP offices may provide more certainty and a framework for applicants.

Consider how IP issues interconnect with the wider regulatory frameworks for AI

Moreover, policymakers and courts will also need to address interconnected concerns. This could include determining the potential infringement of others' rights by AI systems and devising strategies to mitigate bias in both AI systems and the training data sets used, ensuring equitable and ethically sound AI advancements.

AI as an inventor: reflections from a computer scientist

In general terms, patents are available for inventions that are novel, non-obvious and have industrial application.

It appears that many jurisdictions require a human inventor to be named on a patent application and that the inventor is intricately linked with the person devising an invention, the person who had the "inventive spark."

There is much ongoing debate as to whether LLMs are capable of such inventive capabilities and hence we may be bidding farewell to the comforting idea of an "inventive spark" as a distinct human ability.

Currently, AI systems are excellent at absorbing known ideas and applying them across a range of fields. AI systems can use a photo and transform it into a painting in the style of a particular human artist. Efforts are underway to design AI systems for drug discovery that are capable of searching through all scientific literature to identify chemical compounds that may be promising candidates to bind to a particular molecular target.

In doing so, AI systems, unlike humans, are not restrained by limited memory, language barriers or idiosyncrasies of individual scientific communities. In other words, the amount of knowledge accessible to AI is significantly larger than that of human inventors.

Additionally, there is likely to be a significant number of inventions that can be made by combining the knowledge that has already been accumulated and documented throughout the history of science. From this point of view, AI may well be able to assist in generating inventions that are in the "convex envelope" of cumulative current human knowledge. By being able to analyze and combine different sets of knowledge to extract likely pairings, AI may well be able to augment human capabilities by speeding up the process of inventing.

In all the above examples, human input is arguably still required in:

– forming a query to the AI system; this is commonly referred to as "prompt engineering," meaning finding the right input to get the desired output; and
– evaluating an output generated by the AI system, for example by selecting identified molecules that may bind to a particular molecular target and deciding on further testing.

In this way, AI can be considered as another productivity tool, rather than operating and inventing autonomously.

However, even though currently human input is still required, it is reasonable to conjecture that this input will become less and less significant as time proceeds, and AI systems will become more and more capable. Posing or identifying a problem such as "find a drug that cures cancer X" may well be unlikely to represent an "inventive spark" by the operator of the AI system. Should the systems reach a level of capability that such a query would lead to the discovery of a new drug, it is unclear where the "inventive spark" lies. After all, the capability of LLMs rests on two pillars: (1) the data, which is all the knowledge that humankind has accumulated, and (2) the system itself, which was conceived and built by human scientists and engineers.

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3 / Who (or what) is an "inventor" under patent law?

While current AI innovations concern AI models, AI-assisted and AI-based inventions, the DABUS cases (see DABUS box) have served to raise awareness about the legal implications should AI become capable of inventing autonomously (AI-generated inventions).

While AI currently still requires substantial human input, the technology is advancing fast. To shape appropriate IP ecosystems, policymakers need to be able to assess when this future world may become reality, that is, when AI becomes an autonomous inventor. They must consider the options available to them and how best to react when this happens. In broad terms, policymakers will need to keep a close eye on the developing technical capabilities of AI and assess their jurisdiction for how an "inventor" is defined under patent law.

To assist policymakers, this section will outline the patent law perspective and IP law concept of "inventor." Part 4 will then take a closer look at the policy options for that future scenario.

In light of the fast advances in AI technology, an understanding of the requirements to be classed as an "inventor" will allow policymakers to judge when AI is operating autonomously enough and when an invention is AI-generated.

Why does patent law focus on the human inventor?

Most patent laws around the world require a patent application to name an inventor. Inventors are the only ones who can apply for a patent. However, national patent laws do not generally specify who the inventor is or how the inventor should be determined. While some national patent laws expressly state that the inventor is the person or persons who contribute to the claims of a patentable invention[15] or the actual deviser of the invention,[16] this simply shifts the discussion from who the inventor is to one defining the claimed invention. Many other countries provide no explicit details in their patent laws.

The common understanding that an inventor must be a human being has its roots in longstanding cultural and legal traditions. To promote human innovation, inventors get exclusive rights to their inventions for a limited time. In return, inventors must publicly share all the details of their inventions. Patents were seen as rewards to inventors. Historically, an inventor is the "true and first inventor" of a new creation.[17] Patent laws encouraged the disclosure of such inventions to avoid inventors keeping their innovations secret and out of the public domain. Patent rights were thus awarded for bringing an invention into existence and for disclosing it to the public so that others could benefit from it. In fact, historically, an individual was not considered an inventor if they made an invention but did not disclose it.

All around the world, the concept of invention has been intrinsically tied to human ingenuity, creativity and problem-solving skills. Humans have been seen as unique in their ability to innovate and advance technology, with their "fire of genius," and this perception has been ingrained in global patent laws.[18] When these laws were drafted, the focus was solely on human capacity for innovation, as there were no other entities – like AI – thought capable of such feats.

This is why most existing national patent laws have never needed to specify that an inventor must be a human; it was simply assumed.

Who (or what) is an "inventor"? The patent law concept of "inventorship"

Beyond the fact that the inventor is conventionally thought of as a human, and given that national patent laws vary, it is useful to consider some of the common themes and principles from the case law to determine who or what is an inventor, and what contribution is sufficient to allow an inventorship claim.

Such guidance can generally be found in patent disputes. Examples include:

- patent entitlement disputes: one party claims they are the inventor while the patent names a different individual or omits the name of an individual;[19]
- disputes between co-inventors, such as license and compensation claims;
- patent revocation proceedings, for example in jurisdictions that allow a patent to be revoked for inequitable conduct based on the naming of an allegedly incorrect inventor; and
- employee inventorship compensation claims.

The nature of the disputes, their legal basis and determination will of course vary, and decisions may well depend on the individual facts of a case.

Different countries may well take different approaches. While this toolkit seeks to illustrate some of these principles, countries should specify the legal position on inventorship for their jurisdiction.

By way of illustration, a nation's legal position of inventorship can vary:

- In Canada, the Supreme Court decided that the ultimate question for inventorship is "who is responsible for the inventive concept?"[20] Thus the basis of inventorship is built upon the idea of conception. By contrast, a person whose only contribution is to help the invention to completion is not an inventor. For instance, in a case involving an HIV treatment, the court ruled that merely verifying the drug's effectiveness – despite requiring significant skills and efforts – does not make one a (co-)inventor of that drug.[21]
- United States of America patent law is similar on this issue – the "touchstone of inventorship" is described as "the formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention."[22] For that reason, companies in the United States have been barred from inventorship status: people conceive, not companies.[23]
- Statutory law in the People's Republic of China defines an inventor as "any person who makes creative contributions to the substantive features of an invention-creation."
  It explicitly excludes people who are "responsible only for organizational work, or who only offer facilities for making use of material and technical means, or who only take part in other auxiliary functions."[24] A "substantive feature" here refers to "key points of design of invention-creation or key technical features, reflecting technical differences between said invention-creation and the known achievements."[25] Therefore, an inventor must have contributed to features that distinguish the invention from existing patents and are non-obvious to a person skilled in the art.

- In Japan, for someone to be considered the inventor of a patent they must be creatively involved in the completion of the characteristic parts of the invention.[26] In other words, the person named as the inventor should have contributed to the technical concept behind the invention. There are primarily two methods for recognizing inventors, as established by judicial precedent to date.[27] The first method is a two-step test involving 1) formulating an idea for an invention and 2) turning that concept into a practical application.[28] The second method recognizes someone as an inventor if they contribute to creating the "key component" of the invention.[29] With this method, one must first identify the characteristic part of the invention – something that is not found in the prior art and is fundamental to problem-solving and specific to the invention. Additionally, the technical field of the invention can also be a factor in judicial decisions. In the chemical field, for example, it is often not clear, without an experiment, whether a specific invention produces the desired effect.[30]

As the law stands, more than routine skill is necessary.[31] A claimed invention must not be obvious, or very plain, to a person skilled in the relevant art or science.[32] A person, or even a machine, who labors under the guidance or direction of another is not an inventor, despite arduous time invested, dedication and diligence in the work.

Inventorship is consistently tied to creative or intelligent conception of the invention or a contribution to its development, whether explicitly or implicitly. While some jurisdictions focus on conception, others embrace a broader range of material in patent applications. Regardless, the principle remains a creative contribution beyond providing abstract ideas. Offering abstract, business or administrative instructions does not meet the inventive conception criteria, regardless of their importance to the invention. The origin of the "inventive spark" that differentiates an invention from prior art does not need to solely come from the inventor's conscious effort. Inventive activity can be by sheer luck.[33]

Why does AI challenge the concept of a human inventor?

At stake is the type of patent system that society wishes to cultivate. Is the current patent system adequate to address AI's mounting challenges? At the crux of these challenges to the patent system is the very notion of inventorship. Can, and should, an AI "invent" for the purposes of patent law?

Some potential options and their broader economic and social implications as well as the possible ripple effects of each choice on the broader IP legal frameworks are set out in Part 4.

AI and IP: an economic perspective

Note: This is a synopsis of an article examining the relationship between IP and AI innovation from an economic perspective. For further details, please refer to the full article.[34]

AI adoption has surged in recent years, with global corporate AI investment growing from USD 12.75 billion in 2015 to USD 93.5 billion in 2021.[35] The AI market is projected to expand twentyfold from about USD 100 billion in 2021 to nearly USD 2,000 billion in 2030.[36] AI's rapid progress is transforming innovation and industry, offering both opportunities and challenges.

However, AI adoption and development face barriers, including skills shortages, computing requirements and reliance on quality training data, all of which influence how companies innovate. They can build in-house AI capabilities or partner with AI experts. Partnerships have formed between traditional industries, like automotive and pharmaceuticals, and leading tech companies.

AI is not only a tool for creating new products and services but is itself a new method of invention. Therefore, the impact of AI on innovation and IP is of great interest. The legal discourse centers on how the IP system will adapt to AI. However, from an economic perspective, the key question is not whether AI or humans create innovations, but how

AI-driven innovations transform the innovation process and affect the incentive balance in the innovation ecosystem.[37]

The impact of AI on the patent system needs to be understood in the context of the economic rationale for patent protection. The core idea behind patents is to address the *appropriability dilemma* of inventive activities. Inventions, being public goods, can be used by many simultaneously, making it hard for the original inventor to prevent their use. Patents provide exclusive rights to inventions, allowing innovators to financially benefit from their innovations, which in turn funds further research and development.[38]

However, additional economic considerations have refined this rationale. Firstly, innovators have other methods to overcome the appropriability dilemma, such as lead time, secrecy and marketing strategies, which may be more important than patents in some industries.[39] Secondly, innovation is often cumulative and simultaneous, with one innovation building on previous ones. An important function of the patent system is to require the disclosure of patented inventions, which makes it easier for innovators to learn about existing technological knowledge and can avoid duplicative research efforts. Still, dense patent landscapes can pose challenges, especially when access to complementary patents is needed, leading to high transaction costs and power imbalances among innovators.[40]

Does the advent of AI change the innovation incentives posed by the patent system?

The impact of AI on innovation incentives, as governed by the patent system, poses several fundamental questions.

If AI could entirely replace human inventors and AI-generated inventions were not eligible for patents, would innovation suffer? The answer depends on the nature of innovation. If innovation is confined to the inventive processes, with no upfront research and development (R&D) or post-invention development, it might not require patent incentives. However, innovation relies on inventive, non-inventive and capital inputs for R&D and post-invention product development. AI could offer efficiencies, but it might not eliminate the need for patents due to ongoing R&D costs and the expenses of operating AI systems.

The legal question is whether AI reduces the human contribution to invention to the extent that inventions become ineligible for patent protection under existing patent laws. The economic question is whether AI makes R&D significantly more resource-efficient, potentially obviating the need for patent protection. Even if the answer to the first question is affirmative, it does not automatically follow that the same holds true for the second question.

How AI will affect the resource needs for innovation is ultimately an empirical question. Macro trends show no signs to date of companies reducing their R&D investments. On the contrary, R&D spending continues to be on an upward trajectory.[41] Furthermore, to the extent that AI increases the productivity and opportunities of R&D activities, it may well prompt greater R&D investments if companies can appropriate such investments. Another uncertain factor is the regulatory scrutiny that AI research may face in the future, which could significantly raise the costs of R&D. Ultimately, the impact of AI on R&D spending may not be uniform across sectors.

Other factors also affect the role of patents. AI may not only change the nature of R&D, but it may also change business models, which may affect how companies can appropriate their innovation investments. AI could facilitate the reverse-engineering of technology, which in turn would increase companies' reliance on patent protection and enforcement. In the absence of patent protection, companies may seek other forms of IP to appropriate their innovation investments.

A related consideration concerns the disclosure function of the patent system, which can facilitate cumulative innovation. A first question is whether AI-based and AI-generated inventions can meet the disclosure requirement when they use complex "black-box" algorithms[42] and extensive training data that go beyond what traditional patent disclosures cover.[43] A second question is whether reducing dependence on the patent system, whether due to AI-generated inventions not qualifying or because inventors opt for secrecy, could hinder the processes of learning and cumulative innovation.

All these considerations have important economic implications. While the patent ineligibility of AI-generated inventions would act to reduce innovation incentives, much depends on the availability of alternative appropriability mechanisms, evolving business models and the nature of cumulative innovation processes. Shedding empirical light on these implications could be a valuable input for policymakers considering reforms to patent rules.

Policymakers need to follow these developments closely. They face the challenge of monitoring AI developments and considering potential policy reforms without overreacting. However, policy uncertainty can also stifle innovation, as companies may hesitate to employ AI in their activities due to concerns about potential IP rights invalidation.

In considering any policy reform, policymakers face the challenge of looking at emerging evidence on the impact of AI. As in the case of past technological changes, it takes time for stakeholders to adapt, new business models to emerge, courts to interpret law and industry practices to consolidate. In addition, premature policy reforms risk unwarranted consequences and may not account for the self-regulation of markets.

Economists can contribute to the AI and IP debate by providing empirical insights into the evolving landscape of innovation influenced by AI. This includes understanding how AI is altering innovative processes, business models, market competition and supply chain dynamics. They could also explore the impact of AI on inventive labor, given the traditional incentive mechanisms underpinning IP laws. Additionally, studying the ecosystem for the development and access to AI models and how this influences downstream innovation and creativity is crucial.

4 / Getting ready for a world of AI-generated inventions

When AI technology achieves the capability to invent autonomously, how would such inventions generated by AI systems fit within the current IP framework?

IP law has proven to be extremely robust in the face of past technological advancements, but AI-generated inventions challenge the very structure of patent law. In this sense, it is unlike past innovations and will test the fabric of patent law's foundational concepts. Should inventions autonomously generated by AI systems benefit from patent protection? Or should the IP system continue to focus on fostering human innovation? Is this a binary choice or are there alternative solutions?

This section will present policymakers with policy options available to respond to AI-generated inventions.

The existing IP system provides a finely tuned framework that balances different interests, including the rights of innovators and the benefits to society. To avoid unexpected consequences or ripple effects, policy choices will need to be considered carefully both within their socioeconomic context and against the backdrop of the existing IP framework.

Starting point for a policy discussion

As outlined in Part 3, building a solid understanding of the inventorship requirements within a given jurisdiction while closely watching AI's developing technical capabilities will allow policymakers to decide if and when there is a need to consider how the law should address the scenario of AI-generated inventions.

The starting point for a policy discussion is arguably the status quo. This involves examining whether the existing patent laws of a given jurisdiction allow AI to be named as an inventor.

Consensus around AI inventorship may, at least for now, be emerging in some countries. Judicial bodies in multiple countries – including the United Kingdom, the European Patent Office, the United States and Australia – have responded to the DABUS cases (see DABUS box). The starting point for a policy discussion is to determine the status quo, including:

- an understanding of whether a jurisdiction's existing patent laws allow an AI system to be named as an inventor or whether a human inventor is required; and
- an assessment of whether the status quo encourages the desired policy incentives; to this end, a set of guiding principles may be drawn by considering the economic benefits a jurisdiction wants to generate and the social benefits that patent systems can offer (see *AI and IP: an economic perspective*).

Equipped with an in-depth understanding of their local IP ecosystem, policymakers will be best placed to develop the most advantageous solution for their jurisdiction's individual situation.

DABUS

What is DABUS?

DABUS, short for Device for Autonomous Bootstrapping of Unified Sentience, is an AI system developed by Dr. Stephen Thaler.

The DABUS patent

DABUS allegedly autonomously invented a flashing light beacon for emergencies and a fractal food container. These inventions were the subject of a Patent Cooperation Treaty (PCT) application filed in 2019 by Dr. Thaler, with DABUS designated as the inventor.[44] The inventions claimed in this patent application were alleged to be the first examples of AI-generated inventions.

Various IP offices received one or more of these DABUS applications via the national phase or by direct filing. Many IP offices rejected the applications on the basis that the naming of a human inventor was required.[45] In many cases, the applicants appealed these decisions.

Summary of case law[46]

Many jurisdictions have rejected the DABUS patent applications, for example:

- United States courts have been resolute in their stance against AI inventorship, citing statutory definitions and consistent references to inventors as natural persons.
- The United Kingdom is awaiting a judgment from the Supreme Court after the Court of Appeal rejected the DABUS application, underscoring the requirement for the inventor to be a natural person.
- In Canada, the possibility of AI inventorship remains open, provided a human applicant represents the AI.
- Australia briefly allowed AI systems as inventors but later aligned with the global consensus favoring human inventors.
- The European Patent Office, the Intellectual Property Office of New Zealand and the German Federal Patent Court have rejected DABUS's inventorship.

However, the German Court also suggested that there may be scope for AI to be listed as an additional inventor if a human inventor is identified (see *Possible options to respond to AIgenerated inventions*). This potential compromise involves retaining the human inventor requirement while ackno wledging AI's inventive contributions.

DABUS and the AI inventorship debate

These cases highlight the complex issues surrounding AI inventors, as AI-generated inventions challenge conventional notions of inventorship and patent application requirements.

The economic and social purpose of patents

As discussed above, the fundamental purpose of patents is to incentivize innovation and drive economic growth. Patents provide time-limited[47] rights to exclude others from using an invention. Patent theory suggests that this benefits inventors by allowing them to recoup the investment of time and capital spent developing the invention. In turn, society benefits from the promotion of inventive activity, economic growth and industrial development.

As part of a holistic approach to AI regulation, policymakers may want to consider the economic incentives they would like to set in the field of AI innovation. IP laws can then be fine-tuned to achieve these outcomes.

The social benefits of patents extend beyond their pure economic purpose. Without patent protection, inventors may opt to keep the details of their advances a secret, effectively locking away vital knowledge. Depending on the complexity of the invention and the difficulty of reverse-engineering, it could mean some groundbreaking ideas would never get shared and society would be left worse off overall.

Publicly disclosing an invention in a patent application helps to create transparency and safeguards the public by exposing the manufacturing processes and the invention itself. Listing patent holders in the register encourages accountability and can make it easier for regulatory bodies to trace those responsible for compliance and enforcement of standards.

Although patent exclusivities may temporarily limit the availability of innovations, the social intention behind the patent system is that humanity should, in the long term, benefit universally from the advances made. As such, patent laws aim to strike an ethical balance between the private interest of the inventor and the public interest of society at large.

Patent exclusivities are also far from absolute. Certain types of innovations can be excluded from patentability altogether,[48] while some acts – such as non-commercial research and clinical trials – can be deemed non-infringing. Post-grant challenges to the validity of patents add another opportunity to fine-tune the impact of the law. Different jurisdictions vary in the approach taken to achieve the best equilibrium for their legal systems and economic circumstances, and there have been long-standing discussions between stakeholders around the optimal balance.

These considerations highlight the necessity for policymakers to thoughtfully weigh up any prospective amendments to existing patent laws in response to AI-generated inventions.

To develop a balanced framework that continues to promote the economic and social benefits that justify patent laws, factors like the nature of AI-generated invention, any ongoing need for incentives and the desirability of the continued disclosure of inventions will all need to be considered in the context of the entire IP system and its socioeconomic environment.

Possible options to respond to AI-generated inventions

In light of the questions raised by the DABUS cases, policymakers would be well advised to assess their patent laws to determine whether any adjustments are required in response to the potential emergence of AI-generated inventions, bearing in mind the economic and social purposes of patents. Relevant considerations include the following:

- Can the existing IP system provide the desired economic incentives and social benefits in the context of AI-generated inventions?
- Would continuing the status quo disincentivize investment in AI?
- Would recognition of AI inventors undermine the traditional incentives that the patent system provides to human inventors?
- Would allowing AI systems to be named as inventors stretch the fundamental concepts of patent law so far as to make it structurally unworkable?
- Should inventions generated autonomously by AI systems benefit from patent protection?
- Should the patent system continue to focus on fostering human innovation only?

To complicate matters, this is not an exhaustive list of possible options that are being discussed; there may be alternative solutions. The evolution of discussions about the patentability of AI-generated inventions has tended to present the options as a binary choice between recognizing AI systems as inventors or not. However, the issues are in fact far more nuanced and complex.

Policymakers should think beyond the binary question of whether an AI system can or should be named as the inventor on a patent application or not.

Considering a broader range of options is more likely to help jurisdictions to achieve intended policy objectives.

Various options are available to address the question of IP protection for AI-generated inventions, and the most appropriate policy setting in a jurisdiction might consider the degree of contribution that an AI system has made to an inventive process, as well as broader innovation policies. Against the backdrop of these wider considerations, the following options will be addressed:

- Preserve the status quo and continue to recognize human inventors only.
- Revise patent laws to allow an AI system to be named as an inventor or co-inventor.
- Revise patent laws to require a legal person to be named as a proxy for the AI (co-)inventor, while recording the inventive contribution of an AI system.
- Establish a *sui generis* IP law for AI-generated inventions.

Recognize human inventors only

To date, court decisions from around the world appear to agree that the term “inventor” means a *human* inventor under existing laws (see DABUS box). Consequently, AI-generated inventions are currently excluded from patentability in many jurisdictions. However, this conclusion is based on statutory interpretations of patent laws and provisions that were put in place well before the advent of AI and at a time when the idea of a non-human inventor lay in the realm of science fiction (see *Why does patent law focus on the human inventor?*).

This raises a question as to whether it would be beneficial to maintain this status quo or amend patent laws to reflect the changing environment in which inventiveness is now occurring.

Advocates in favor of strictly limiting the patent “inventor” role to humans put forward a variety of reasons to support the notion that AI-generated inventions should be barred from patentability. Some of these are based on the justifications for patent law, and others are founded on more pragmatic concerns about the structure and functionality of the patent system.

Limiting patents to human inventors aligns with justifications for patent laws

Arguably, patent law was developed to incentivize and reward human innovation only. Therefore, if AI systems invent autonomously and without human involvement, there is no nexus between human ingenuity and the invention to justify the grant of a patent monopoly. In this view, only human inventiveness unaided by AI systems would be justified.

A related argument is based on the notion that AI systems do not need to be rewarded for their efforts. This perspective suggests that AI systems are not driven by human motivations, so they will not suffer any injustice or be disincentivized by the inability to commercialize their inventions. Nor will they suffer harm if others copy their inventions, as AI systems are non-sentient and therefore lack any moral imperative to be attributed as the inventor.

Further concerns have been raised that the ability of AI systems to combine huge amounts of seemingly disparate information may render many human-made innovations "obvious" or lacking an "inventive step," and therefore unpatentable. This could crowd out most human inventions from patentability and, in turn, challenge the fundamental justifications on which patent law has been built over the centuries. It could even have broader implications if the gap in opportunities were to widen between those people and jurisdictions with access to the latest AI technologies and those without. Viewed from this perspective, excluding from patentability inventions devised by AI systems might help to preserve opportunities for human inventors, and prevent inequalities in access to technologies from becoming further entrenched.

Along the same lines, the ability of AI systems to systematically identify knowledge gaps and invent accordingly could narrow the scope for invention by others. While it might lead to a burst of creative activity and a surge of useful inventions for humans to benefit from, allowing these inventions to be patented would turn them into private property. In a worst-case scenario, this could become so extensive that it might create a dense web of patents that leave little scope for others to develop related products or technologies during the term of the patents. This thicket-like effect could undermine the justifiability of the patent system more generally.

The arguments of those who favor maintaining the status quo based on the purpose of the patent system can therefore be summarized as follows: as AI systems do not need incentives to invent, and as they are oblivious to the economic or moral rewards of inventorship, AI-generated inventions should become a public good free to be used by all.

Pragmatic reasons to limit patents to human inventors

Others favor maintaining the status quo due to pragmatic concerns about the structure and operation of the existing patent system. Proponents of a conservative approach based on these grounds point to a range of practical problems that the patent system may face if AI-generated inventions were to become patentable.

Arguments from this perspective have raised concerns about the continued workability of the underlying concepts on which patentability rests if AI-generated inventions were to be patentable. For instance, patent law's fundamental concepts of "inventive step" or "non-obviousness," and "person skilled in the art" may be difficult to apply in an environment of AI-generated inventions in which everything is obvious to an AI system, and in which the notional "skilled person" is an AI system that has been trained on or can access all published knowledge to date.

Questions have also been raised about who would own a patent if an AI system were to be recognized as an "inventor" for patent purposes, but that system did not have legal personhood and could therefore not own property. Who would be responsible for the patent application? And who could enforce the patent?

Separate concerns have been raised about the capacity of patent authorities to cope with potentially vast quantities of patent applications for AI-generated inventions. On this view, the ability of AI systems to generate an immense number of innovations (and perhaps also draft and submit their own patent applications) could potentially overwhelm the capacity of patent registration offices to process the applications. The patent system could arguably become unsustainable if it became so choked that patent offices and courts lacked the capacity to examine and assess the volume of applications.[49]

Weighing up options

If the status quo were to be maintained, the same invention would either benefit from patent protection if made by a human inventor or become part of the public domain if generated – in whole or in part – by an AI system.

Proponents of these arguments suggest that leaving AI-generated inventions unpatentable could promote accelerated innovation, as inventors will be permitted to improve upon and use AI-generated inventions freely. In turn, this may foster an environment of open innovation that could lead to the development of cheaper products being made available more rapidly for the benefit of all.

However, it is also possible that this approach could give rise to a perverse outcome unless other amendments were put in place as safeguards. Given the potentially significant economic value of a patent, it has been suggested that maintaining the status quo encourages false declarations about the origin of an invention. In many jurisdictions, incorrectly identifying the inventor is a ground for rejecting an application or revoking a granted patent, and it is foreseeable that patents could be challenged on the basis that an invention had been falsely declared to be the product of human inventiveness when it had in fact been devised by an AI system. As it would be difficult for adjudicators to ascertain who or what developed the invention and, therefore, to enforce the requirement for human inventorship, this could lead to practical enforcement problems unless patent laws were amended to include a requirement to disclose how an invention was made.

Revise patent laws to allow an AI system to be named as a sole or co-inventor

An obvious alternative to the status quo would be to remove any requirement stating that a pre-condition for patentability is that an inventor is human. This could be done, for example, by amending existing patent laws to expressly define the term "inventor" to include both human and non-human inventors. Unless any provisions to the contrary were also adopted, human-generated and AI-generated inventions would then be treated identically and become eligible for equivalent patent protection.[50]

Following traditional justifications for patent laws, those advocating for patent protection for AI-generated inventions suggest that this would encourage further investment in AI-related R&D. Incentivizing investors and the developers of AI systems could lead to an increase in AI-generated technological innovations. At a macroeconomic level, these effects could also help to stimulate economic growth and produce the same sorts of social benefits generated by patents protecting human-generated inventions.

Proponents of this approach also argue that the disclosure function of patents would encourage the sharing of technical specifications for AI-generated inventions, thereby promoting the dissemination of knowledge that might otherwise remain secret. In turn, this could lead to greater transparency and accountability in the use of AI technologies. However, it has been argued that the opaque way in which some AI systems operate is not understood by human operators, and therefore could not necessarily be explained in a patent application. This might mean that even if an AI system could be named as an inventor, other criteria for patentability could not be met.

The view that an AI system should be able to be named as a sole or co-inventor is supported by the argument that innovation policy should focus on the importance of the patented invention rather than whether it has been invented by a human or an AI system. If patents are intended to incentivize innovation, does it matter who has been incentivized or what type of entity has created the invention? While inventors are currently named in patent applications, the economic benefits of patented inventions are not linked to their inventors in perpetuity. Inventors do not always end up as the owners of their inventions, for example, if they are employed to invent.

However, while patent law's separation of the roles of the inventor and owner may provide an argument in favor of recognizing an AI system as an inventor, it also provides an argument against it. That is, if AI-generated inventions were to be patentable, who would be the owner of the patent?

Patent ownership currently flows from the inventor(s). In jurisdictions in which AI systems do not have the rights of people or corporations, they could not own a patent. A comprehensive legal framework would need to be developed to determine when ownership rights would be assigned to human or corporate persons associated with the AI system that solely or collaboratively generated an invention.

One approach would acknowledge the various contributors to the inventive process. Co-inventorship is a well-established concept in patent law and may provide a way to balance and award patent rights to stakeholders while reflecting the multi-contributory nature inherent in much AI technology. Options might include affording sole or co-ownership to the person(s) (human or corporate) who trained and developed the AI system, or that owned or operated the AI system when it generated the invention. Alternatively, legal person(s) whose intellectual, technical or financial support was integral to the creation of the invention could be rewarded with either sole or co-ownership. This could include data providers. These approaches acknowledge the multiple contributors to the development and operation of an AI system and would allow ownership shares to be allocated in various ways depending on the underlying factual scenario. Even if human contributors have not made a substantive contribution to the actual invention, it allows a range of human parties to share the ownership of the patent. This type of approach would also enable the legal system to ensure the owner(s) would not only acquire rights to the patented invention but would also assume obligations and legal liability for its use. However, if ownership becomes too fragmented, it may lead to difficulties in effectively determining, managing and enforcing the rights and obligations associated with the patent.

This approach would necessitate a substantial revision of legal principles and major legislative changes. This could introduce new legal uncertainties and there could also be other repercussions. The arguments outlined earlier as reasons to recognize only human inventors also point to potential problems that could arise from allowing the patenting of AI-generated inventions (see *Recognize human inventors only*).

Revise patent laws to require a person to be named, while recording the inventive contribution of an AI system

It was suggested above that more nuanced options exist beyond the blunt positions of either prohibiting the patenting of AI-generated inventions or permitting them outright. One alternative could be to adapt the existing patent system to accommodate AI-generated inventions by changing the requirement that a human inventor be named to a requirement that a human also be named, or that a legal person be named as the sponsor for all patents claiming AI-generated inventions.

The existing requirement that the human who devised the invention be named on the patent application allows the identification of the human(s) responsible for bringing the invention into existence and ensures that the human(s) contributing to the technological advancement can be rewarded (see *Why does patent law focus on the human inventor?*). While the default position is that the inventor is the person who is entitled to apply for a patent, patent law already recognizes several exceptions to this. Examples include an employee who is hired to invent or an inventor who sells their invention to new owners. In both cases, the non-inventive owner is entitled to file the patent application and obtain ownership of the patent. By analogy, naming a person in conjunction with an indication that the invention was AI generated may provide solutions to the ownership question.[51]

In the interests of clarity, the nominal person could be distinguished from the inventor by being defined as a "sponsor." The sponsor might, for example, be a human who trained, developed, owned or operated the AI system. If a jurisdiction wished to extend the scope of this role, a corporation that caused these actions to occur could also be identified as the sponsor.

Naming a sponsor with a legal personality would also solve the issue of accountability for a patent (application). An AI system that lacks this status cannot sue or be sued. By requiring a human or corporation to be named as the sponsor, the legal system would have a legal entity to hold accountable for the invention. The sponsor could also maintain the responsibility to provide sufficient and complete disclosure of the invention and to answer any queries during the patent examination process.

Such an approach would minimize the risk that a fabricated human inventor might be named to conceal the AI-generated nature of an invention (see *Recognize human inventors only*). This approach would also permit the classic inventor-to-owner chain of proprietorship to be maintained while being transparent and honest about the role of AI in the inventive process.

However, revising patent laws to require a legal person to be named while recording the inventive contribution of an AI system is not without risks. The potential problems mentioned earlier concerning other approaches to allowing the patenting of AI-generated inventions could also arise in this context (see *Recognize human inventors only*).

Establish a *sui generis* law for AI-generated inventions

Given the potential difficulties of excluding AI-generated inventions from patent protection completely or, alternatively, somehow trying to fit such inventions into the patent system, some commentators have instead raised the option of creating a new *sui generis* IP right for AI-generated inventions.

Due to its independence from the patent system, this could be a viable option for those who believe that patent protection is not appropriate for AI-generated inventions, but who nonetheless foresee economic and social benefits arising from the provision of some form of IP protection.

An advantage of developing a new *sui generis* "AI-IP" law would be that it could be tailored specifically to reflect the inventive processes used by AI systems. The rules for inventorship, ownership and other challenges to patent law could be adapted or reimagined to suit AI-generated inventions. These include the standards of inventive step and non-obviousness (e.g., would they be judged by standards of human inventiveness or AI inventiveness?), disclosure (e.g., how would data sets and the operations of algorithms need to be disclosed?) and examination (e.g., would AI examiners be needed to assess the technical contributions of generative AI systems?).

A bespoke *sui generis* approach would not be constrained by established concepts; it could incorporate features from other areas of IP law. For instance, if the inventive step standard of patent law was determined to be unsuitable in the context of AI-generated inventions, it could be replaced with an "originality" standard emulating "authorship" in copyright law or different definitions or thresholds of patent-inspired "inventiveness" could be adopted. It could incorporate disclosure requirements for algorithms, training data and the methodologies used to power generative AI systems, as well as the flexibility to adapt to an ever-evolving technological landscape. It could provide for more nimble examination processes than existing patent systems, as well as shorter terms of protection, and different rights and enforcement mechanisms. In short, a new approach such as this would allow policymakers to design an IP law that is aligned with the incentives they are seeking to put in place.

New ethical principles could also be built into a *sui generis* IP law. These could address issues such as biases, accountability, misuse, fairness and equity, which are common in discussions of AI systems and IP laws alike. To promote the ethical and responsible use of AI systems, the social impact of inventions might also be another consideration (e.g., akin to non-patentable subject matter in patent law).

However, the option to design a *sui generis* IP right for AI-generated inventions is certainly not without its critics. Some would be opposed to extending IP protection to AI-generated outputs altogether. Others would fear that awarding IP protection to AI-generated innovations could lead to a handful of powerful entities monopolizing access to AI-generated technologies and their innovative output.

It would be important to design and coordinate provisions to prevent overlap or conflict between a *sui generis* AI-IP law and existing patent law. This might involve incentives such as faster and cheaper protection than traditionally afforded by the patent system, as is common with utility model patents compared to standard patents. Or provisions designed to ensure that parties do not "game the system," such as those designed to exclude registrable designs from copyright protection in some jurisdictions. For example, if the *sui generis* law were to provide a shorter term of protection for AI-generated inventions than patents for human-generated innovations, requiring patent applications to provide full disclosure as to how innovations were devised might help to overcome the risk of applicants using the wrong type of IP law to protect their AI-generated invention. Plant variety protection and laws protecting integrated circuit layouts are examples of two existing *sui generis* areas of IP law that could be used as exemplars of how to navigate some of these challenges.

Devising a *sui generis* law would be a significant undertaking but it is an option for lawmakers to consider. To prevent undesirable outcomes when seeking to protect AI-generated inventions, it would be essential for policymakers to consider the diverse views of all stakeholders when drafting a *sui generis* law to provide IP protection for AI-generated inventions. Whether or not such a law would also extend protection to AI-assisted inventions would be a decision that lawmakers in a particular jurisdiction could make after weighing all the options.

Possible ripple effects

Policymakers face a multitude of challenges and opportunities when considering how to deal with AI-generated inventions. Each option carries advantages and drawbacks, and any action taken – or not taken – could result in unintended negative consequences. The IP system is a finely balanced framework of laws that seek to strike a balance between different interests, economic incentives and social impact. Patent laws are a central pillar within that framework, and policymakers should carefully consider the various options before deciding if, and how, to extend IP protection to AI-generated and AI-assisted inventions within their jurisdictions.

Various risks of unwanted implications have been raised in the discussion of options above. Some relate to ethics, the overriding social and economic purpose of patent incentives and how to reflect this in the age of AI-generated inventions. Other risks arise more specifically because of the nature of AI-generated inventions and the unique challenges they present to existing patent laws. These include the impact of AI on human inventions, how best to distinguish between AI-generated and human-generated inventions and the compatibility of AI inventiveness with existing patent jurisprudence. Some commentators have raised concerns that applications for patents for AI-generated inventions could also overwhelm the system.

Possible actions for policymakers to prepare for AI-generated inventions

Even if AI has not yet achieved the ability to invent autonomously, the complexities set out above suggest it would be prudent for policymakers to start considering the options for the future now. Existing IP laws define the current status quo. However, trying to shoehorn AI-generated inventions into prevailing legal definitions seems unlikely to provide lawmakers with the best approach for designing the innovation ecosystem to achieve their policy goals for the future.

While it is essential to proceed with caution throughout this process, the rapid pace at which AI technologies are evolving suggests it will be vital to carry out the task both promptly and swiftly.

It may instead be helpful to consider a spectrum or mixture of options. While some concerns could potentially be mitigated by the careful use of existing policy levers (e.g., by amending existing definitions in patent law), others might be overcome by developing a bespoke *sui generis* IP law. Policymakers' paths through the different options will be assisted by going back to basics and recalling the underlying economic and social goals of the patent system. Patent laws are designed to incentivize and reward inventiveness in a manner that balances both the economic interests of the inventor and the public good of society. In weighing up options for protecting AI-generated inventions, the justifications for IP laws generally, and policy goals in relation to AI, should ideally be considered in the context of the entire IP system and its socioeconomic environment in a jurisdiction. Policymakers may also want to be mindful of the possible repercussions that could arise in their respective jurisdictional contexts. Being aware of these potential "ripple effects" is essential to avoid unintended consequences.

A solid starting point would be to hold an inquiry aiming to build a detailed understanding of the needs and desired outcomes of various stakeholders in the jurisdiction. Consideration of any amendments to existing IP law to accommodate AI-generated inventions may be best served by engaging in an integrated, multi-stakeholder approach. Bringing together private enterprises, AI innovators, existing IP owners, consumer advocates, IP professionals and academics will allow policymakers to identify and balance their diverse interests. Comprehensive public consultations with experts from a range of areas, who are invited to comment on legal, ethical, pragmatic and regulatory issues, may be an effective way to commence this review to establish policy goals. Options will then need to be analyzed carefully, and recommendations made to start shaping legal solutions that are consistent with the fundamental purpose of the patent system, and that work in harmony with other areas of IP law.

Annex
Case studies

CropLife Latin America:
An example of new AI models or algorithms, and data

CropLife Latin America's members are an example of companies developing AI models. Data sets are at the center of their business models.

CropLife Latin America is the regional association of CropLife International, a non-profit industry trade association that promotes sustainable agriculture to protect biodiversity and safeguard food supply. The association represents, for example, Bayer CropScience, Sumitomo Chemical, FMC, Syngenta, BASF and Corteva Agriscience.

CropLife aims to assist farmers in producing more in less arable land. Technological advances have always been part of agricultural progress, for example, by mechanization or irrigation technologies. Agriculture 4.0 (also known as smart agriculture, precision agriculture or digital agriculture) represents the next wave of technological advancements. Powered by AI algorithms and real-world data, Agriculture 4.0 enables comprehensive land analysis, helping farmers select suitable crops, improve water efficiency, and optimize fertilizer and pesticide use.

Operating in the AI field raises the following IP issues for CropLife:

- How to protect AI models developed to recommend, for example, suitable crops or pesticides, or to optimize irrigation. Options include copyright or software patents but there is some uncertainty about patenting AI models.
- How to manage data access and protection. Data are often in the hands of individual farmers, and satellite or drone imagery may be protected by copyright. This raises questions on two fronts: first, how to obtain licenses to data, and second, how to protect the rights in data sets that are being generated when the data are collated into wider training data sets so they can be licensed.

At the core of Agriculture 4.0 are AI models and data. IP protection is key to allowing fair access to data, as well as licensing of the AI algorithms and trained models, and safeguarding from unauthorized copying.

The member companies of CropLife Latin America use bundles of different IP rights to protect their investments in innovation and scientific development, including patents, trade secrets, plant variety protection, copyright, trademarks and database rights.

The IP portfolios are also structured internationally to protect future markets and monitor potential infringements.

Hello Tractor, Kenya:
An example of new AI models or algorithms, and data

Hello Tractor is an example of a company developing AI models. Data sets are at the center of their business model.

Hello Tractor is an agrotechnology company dedicated to improving food and income security in sub-Saharan Africa.

The company has developed an AI-based predictive AI model aimed at enhancing tractor utilization. Resource-poor farmers often face constraints that result in under-cultivation, late planting, late harvesting and lost income. Hello Tractor facilitates accessible and cost-effective tractor services for these farmers. For tractor owners, Hello Tractor's virtual tractor monitoring platform provides remote tracking and provision of spare parts for repairs, preventing fraud and machine misuse. Efficient tractor monitoring places Hello Tractor at the nexus between tractor owner profitability and farmer productivity.

Hello Tractor's services rely on historic GPS records, up-to-date satellite imagery and third-party data that together make up proprietary training data sets for the company's AI models.

Operating in the AI field raises the following IP challenges for Hello Tractor:

- How to use IP to protect AI models for virtual tractor monitoring.
- Drafting patent applications for Hello Tractor's inventions requires attention to the technical aspects of the invention. Demonstrating how the model interacts with a technical system or solves a technical problem is critical to meeting the criteria for patent protection across different jurisdictions. The patentability of these AI models may vary depending on the jurisdiction in which Hello Tractor is pursuing protection.
- Given the reliance on data from several sources, it is critical for Hello Tractor's business to ensure authorized access to input (training) data and to establish clear ownership rights for any output data generated by the AI model. This affects data sharing and data monetization and carries a risk of potential disputes over ownership rights.

To address these challenges Hello Tractor relies on a combination of IP rights, including copyright and software patents, and contractual agreements.

Additionally, awareness of the importance of the IP system in sub-Saharan Africa remains limited among African firms. Hello Tractor is committed to raising awareness and providing training on incorporating IP strategies into business practices. The company encourages knowledge sharing and effective use of IP to accelerate the commercial exploitation of inventions in the African region.

Digi Smart Solutions, Tunisia:
An example of new AI models or algorithms and AI-based inventions

Digi Smart Solutions is an example of a company developing AI models and incorporating them into AI-based tools and services.

Digi Smart Solutions is a Tunisia-based company offering a variety of end-to-end Internet of Things (IoT) applications that improve efficiency and sustainability. The IoT applications address challenges such as food security and production, the reduction of food waste in fisheries, energy efficiency and water conservation.

By way of example, the company produces IoT-based tools and services for water quality management, utilizing AI. The system collects data from IoT sensors and feeds the data to an AI algorithm connected to a mobile or web-based dashboard. This dashboard enables real-time monitoring of water quality, supporting intelligent decision-making, for example for fish farm water management.

Digi Smart Solutions needs to navigate several IP issues including the following:

- How to ensure that its AI models and AI-based tools and services do not infringe third-party IP rights.
- How to best describe the AI model and training data in a patent application. This includes distinguishing different data types, the data processing method, and its significance to the claimed invention.
- How much data to disclose in the patent application to comply with the sufficiency of disclosure requirement and in turn also allow licensing and commercialization of the claimed invention.

Digi Smart Solutions has chosen to patent its technology, as this provides for an accurate disclosure and description of the underlying invention. In turn, the patents enable the company to exploit the technology and allow wider use of it, for example by licensing arrangements and forming partnerships. The company sees patents as a basis for securing finance.

In addition, Digi Smart Solutions relies on contractual frameworks to safeguard its AI models and AI-based tools and services. Contractual terms provide clarity on ownership, control and IP-based financing and assist in navigating the current legal uncertainties in the AI space.

SigTuple, India:
An example of an AI-based invention

SigTuple, an India-based company, operates at the intersection of AI and healthcare.

SigTuple is seeking to transform medical laboratory microscopy. The company's smart screening solutions aim to enhance the efficiency and speed of medical diagnoses by automating microscopy using robotics and interpreting visual medical data using AI.

This is particularly relevant in regions where patients are located at a significant distance from a hospital, for diseases where specialist pathology consultation is necessary or where it is beneficial to enable remote collaboration between medical teams.

SigTuple was founded in 2015. In 2018 it released its first prototype AI100, an in vitro AI and robotics-based diagnostic device designed to automate manual microscopy in a diagnostic laboratory. Its first Indian patent was granted in January 2019 after which series C funding was successfully raised in February 2019.

By 2023 the company held 23 patents in India and the United States. SigTuple recognizes the immense importance of IP as a tool for ensuring steady business growth and is committed to fostering an IP-centric culture within the organization.

SigTuple has encountered various IP challenges along its path to business success, including the following:

- To be patentable, an invention needs to be new, non-obvious and have a technical effect. For AI-based inventions, it is often unclear whether the use of AI changes the legal standard for these criteria, especially considering that the approaches of different jurisdictions can differ significantly.
- When seeking patent protection for AI-based inventions, how much of the AI model and training data needs to be disclosed?
- AI models require access to medical data to be trained, raising significant questions of data ownership and control, and the intersection of privacy and data rights.

While SigTuple is very alert to the importance of IP as a tool to facilitate its global expansion, it is often unclear how to identify the most promising markets and shape an IP strategy that will reflect this.

Sign-Speak, United States of America: An example of an AI-based invention

Sign-Speak, a startup based in the United States, uses AI models to simultaneously translate American Sign Language (ASL) into speech and vice versa. The company's assistive technology solutions and APIs (application programming interfaces) allow easy communication with the deaf and hard-of-hearing population, aiming to give a voice to all those who cannot speak.

Sign-Speak faces the following IP issues:

- How to ensure authorized access to the data used to train AI models.
- How to protect proprietary data sets that are generated by the data from individuals using the Sign-Speak technology so that they can be licensed to third parties.
- Whether to rely on copyright to protect its AI models or try to obtain patent protection for the inventive aspects of AI, considering that the approach to this can vary widely across jurisdictions.
- For AI-based inventions, it is often unclear whether the use of AI changes the legal standard for technical effect under the inventive step requirement, and approaches across the world can vary.
- How much of the AI model and training data needs to be included in a patent application to meet the sufficient disclosure requirement.
- How to define a clear strategy for technology mapping, industrial design protection, leveraging cost-effective IP tools and identifying potential collaboration opportunities.

The company has also filed two patent applications, focusing on sign language recognition from a 2D camera, bidirectional language models and an avatar production system, but it is still working to put in place a concerted IP strategy.

Jendo Innovations, Sri Lanka: An example of an AI-based invention

Jendo Innovations is a Sri Lanka-based startup that provides preventive solutions for cardiovascular health using AI.

Jendo's highly scalable, non-invasive system comprises a sensor clipped to a patient's finger and AI-based analysis of the sensor data. The sensor measures and collects data across 16 parameters including temperature, pulse, oxygen saturation and blood circulation patterns in the deepest cell layers of blood vessels known as the endothelium. The data are then analyzed by Jendo's proprietary algorithm and ML techniques. Through a cloud-based mobile application, the patient is provided with risk-based probabilities for a 10-year period for heart disease, diabetes and kidney disease together with lifestyle recommendations.

Jendo must navigate several IP questions, including the following:

- How to comply with sufficient disclosure requirements for AI models and associated training data.
- How to secure authorized access to the data used for training and validating the AI system without infringing copyrights, privacy rights or other IP rights.
- How to determine inventorship and ownership of Jendo's innovations, which are often based on collaborative efforts between employees, contractors and partners.
- As different countries have different approaches to IP questions, Jendo is also concerned about how to best put in place a national and international IP strategy.

The company has filed patent applications in Sri Lanka, the United States and Japan, through the PCT, aiming to use patents as a tangible tool in substantiating the economic value of the inventions in international markets.

Meticuly, Thailand:
An example of an AI-assisted invention

Established in Thailand in 2017, Meticuly is a pioneer in delivering personalized healthcare solutions, utilizing an AI-powered cloud and 3D printing technology.

By evaluating patient-specific computed tomography (CT) scan data and leveraging the company's extensive database, Meticuly's system offers individually tailored bone implants. This ensures the implant matches the patient's unique anatomy and requirements to an exceptional degree.

Meticuly's IP considerations include the following:

- When filing patent applications, how to best identify the inventor. Who is the inventor: the data provider, the AI model developer, the user or the owner of the AI?
- How to best ensure authorized access to the data used to train AI models by making sure to secure licenses for personal data.
- How to best protect and safeguard proprietary data sets generated when individual patient data are aggregated into extensive training sets, and how to license such data sets.
- How to meet the inventive step requirement and sufficiency of disclosure requirements for AI-assisted inventions.

To date, Meticuly has filed six patent applications via the PCT and holds several trade secrets concerning printing control parameters and confidential aspects of the manufacturing process.

Meticuly aims to implement an IP management strategy that safeguards the company's IP assets while monitoring IP rights to avoid infringing on other entities' rights in the market. The company continuously re-evaluates its IP strategy to account for new developments and inventions.

Notes

1 Merchant, A. *et al.* (2023). Scaling deep learning for materials discovery, *Nature*, 624, 80–85. https://doi.org/10.1038/s41586-023-06735-9

2 WIPO (2019). *WIPO Technology Trends 2019: Artificial Intelligence*. Geneva: WIPO. https://www.wipo.int/publications/en/details.jsp?id=4396; WIPO (2022). *World Intellectual Property Report 2022: The Direction of Innovation*. Geneva: WIPO. https://www.wipo.int/wipr/en/2022/

3 IFI Claims Patents Services (2023). IFI Insights: Opening the Patent Picture on Generative AI. https://www.ificlaims.com/news/view/ifi-insights-generative-ai.htm

4 Cuntz, A., Fink, C., and Stamm, H. (2024) [forthcoming]. *Artificial Intelligence and Intellectual Property: An Economic Perspective*. Geneva: WIPO.

5 Training Chat GPT-3 required a supercomputer with more than 285,000 processor cores and 10,000 graphics cards, equivalent to about 800 petaflops of processing power, which equates to USD 3.2 million in computing resources alone. See Langston, J. (2020). Microsoft announces new supercomputer, lays out vision for future AI work. https://news.microsoft.com/source/features/innovation/openai-azure-supercomputer/

6 WIPO (2019). *WIPO Technology Trends 2019: Artificial Intelligence*. Geneva: WIPO. https://www.wipo.int/publications/en/details.jsp?id=4396; WIPO (2022). *World Intellectual Property Report 2022: The Direction of Innovation*. Geneva: WIPO. https://www.wipo.int/wipr/en/2022/

7 WIPO (2019). SCP/30/5, Background Document on Patents and Emerging Technologies. https://www.wipo.int/meetings/en/doc_details.jsp?doc_id=438393

8 A recent decision in the United Kingdom High Court was the first find that an artificial neural network does not constitute a computer program and is not excluded from patentability. See Emotional Perception AI Ltd v Comptroller-General of Patents, Designs and Trade Marks [2023] EWHC 2948 (Ch).

9 Norvatis (2023). PTO-P-2022-0045-0051, Comments to the United States Patent and Trademark Office (USPTO) Regarding AI and Inventorship. https://www.regulations.gov/comment/PTO-P-2022-0045-0051

10 Abbott, R. (2023). PTO-P-2022-0045-0040, Comments to the USPTO Regarding AI and Inventorship. https://www.regulations.gov/comment/PTO-P-2022-0045-0040

11 For example, the USPTO published Inventorship Guidance for AI-Assisted Inventions on 13 February 2024 https://www.federalregister.gov/documents/2024/02/13/2024-02623/inventorship-guidance-for-ai-assisted-inventions

12 A recent decision in the United Kingdom High Court was the first find that an artificial neural network does not constitute a computer program and is not excluded from patentability. See Emotional Perception AI Ltd v Comptroller-General of Patents, Designs and Trade Marks [2023] EWHC 2948 (Ch).

13 Someone qualifies as a joint inventor if they contribute to the inventive concept or main idea or contribute a separate element that is essential to completing the invention. Joint inventors do not have to contribute to every aspect of the initial idea. See Gotthardt, L. (2023). Inventorship standards, joint inventorship and procedures in inventorship disputes in U.S. patent law and German patent law, *GRUR International*, 72(2), 109–119. https://doi.org/10.1093/grurint/ikac138

14 Brooklyn Law Incubator & Policy Clinic (2023). PTO-P-2022-0045-0043, Comments to the USPTO regarding AI and inventorship. https://www.regulations.gov/comment/PTO-P-2022-0045-0043

15 In the United States, see *Burroughs Wellcome Co. v. Barr Laboratories, Inc*, 40 F.3d 1223, 1227 (Fed. Cir. 1994); *Seawall v. Walters*, 21 F.3d 411, 415 (Fed. Cir. 1994); *New Idea Farm. Equip. Corp. v. Sperry Corp.*, 916 F.2d 1561, 1566 n.4 (Fed. Cir. 1990).

16 In the United Kingdom, see The Patents Act 1977 (as amended), section 7.1 (3); Stanelco Fibre Optics Ltd's Applications [2005] RPC 15 illustrated that more than a theoretical proposal is required to be an "actual deviser" of the patent.

17 Statute of Monopolies 1624, Jac. 1, c. 3.

18 Vaver, D. (ed.) (2011). *Intellectual Property Law: Copyright, Patents, Trademarks*, 2nd edn. Toronto: Irwin Law, p. 271; Lincoln, A. (1859). Second lecture on discoveries and inventions. In Vaver, D. (ed.) (2006). *Intellectual Property Rights: Critical Concepts in Law*. London & New York: Routledge, vol. 3, pp. 31–36.

19 See *Comstock Canada v. Electec Ltd* (1991) 38 CPR (3d) 29 (Fed. TD).

20 *Apotex Inc. v. Wellcome Foundation Ltd*. [2002] 4 SCR 153 at para. 96.

21 *Apotex Inc. v. Wellcome Foundation Ltd*. [2002] 4 SCR 153 at para. 96.

22 *Burroughs Wellcome Co. v. Barr Laboratories, Inc*, 40 F.3d 1223, 1227 (Fed. Cir. 1994); *Seawall v. Walters*, 21 F.3d 411, 415 (Fed. Cir. 1994).

23 *New Idea Farm. Equip. Corp. v. Sperry Corp.*, 916 F.2d 1561, 1566 n.4 (Fed. Cir. 1990).

24 Rule 13 of Implementing Regulations of the Patent Law of the People's Republic of China. https://english.cnipa.gov.cn/col/col3068/index.html

25 Shanghai No. 1 Intermediate People's Court (2011) Hu-Yizhong-Minwu(zhi) -Chu-Zi No.1.

26 Tokyo District Court of Aug. 27, 2002, Hanrei jiho No. 1810, p. 102.

27 Yoshida, E. (2022). Artificial intelligence-related invention in Japan and its disclosure with a focus on human intervention. In Mendoza-Caminade, A. (ed.), *L'entreprise et l'intelligence artificielle – Les réponses du droit* [online]. Université Toulouse 1 Capitole: Presses de l'Université Toulouse Capitole, pp. 225–247. https://doi.org/10.4000/books.putc.15392

28 Yoshifuji, K. and Kumagai. K. (ed.) (1998). *Tokkyo Hou Gaisetsu*, 13th edn. [*Overview of Patent Law*.] Tokyo: Yuhikaku, p. 188 [in Japanese].

29 Intellectual Property High Court of July 30, 2007, Heisei 18 (Gyo-Ke) 10048.

30 Intellectual Property High Court of May 29, 2008, Hanrei jiho, No. 2018, p. 146.

31 *Coleman v. Dines*, 754 F.2d 353, 359 (Fed. Cir. 1985); *Mergenthaler v. Scudder*, 11 App. D.C. 264, 276, 1897 C.D. 724, 731 (1897).

32 Vaver, D. (ed.) (2011). *Intellectual Property Law: Copyright, Patents, Trademarks*, 2nd edn. Toronto: Irwin Law, p. 328.

33 Shemtov, N. (2019). *A Study on Inventorship in Inventions Involving AI Activity*. Munich: EPO. https://link.epo.org/web/Concept_of_Inventorship_in_Inventions_involving_AI_Activity_en.pdf

34 Cuntz, A., Fink, C., and Stamm, H. (2024) [forthcoming]. *Artificial Intelligence and Intellectual property: an economic perspective*. Geneva: WIPO.

35 Statista (2023). Global total corporate artificial intelligence (AI) investment from 2015 to 2022. https://www.statista.com/statistics/941137/ai-investment-and-funding-worldwide/

36 Statista (2023). Artificial intelligence (AI) market size worldwide in 2021 with a forecast until 2030. https://www.statista.com/statistics/1365145/artificial-intelligence-market-size/

37 Recent announcements include, for example, new AI-focused partnership between Microsoft and Novartis (Microsoft News Center (Oct. 1, 2019) https://news.microsoft.com/2019/10/01/novartis-and-microsoft-announce-collaboration-to-transform-medicine-with-artificial-intelligence/) as well as Google and Volkswagen (Google Blog (Sept. 28, 2022) https://cloud.google.com/blog/products/ai-machine-learning/volkswagen-uses-google-cloud-ai-for-more-efficient-cars).

38 See WIPO (2011). *World Intellectual Property Report: The Changing Face of Innovation*. Geneva: WIPO (https://www.wipo.int/publications/en/details.jsp?id=227) for a more detailed analysis of how the incentives posed by the patent system compare to other policies that support innovation.

39 WIPO (2011). *World Intellectual Property Report: The Changing Face of Innovation*. Geneva: WIPO. https://www.wipo.int/publications/en/details.jsp?id=227

40 Scotchmer, S. (2004). *Innovation and Incentives*. Cambridge: MIT Press.

41 WIPO (2022). *Global Innovation Index 2022: What Is the Future of Innovation-Driven Growth?* Geneva: WIPO. http://dx.doi.org/10.34667/tind.46596

42 An algorithm where the user cannot see its inner workings.

43 Ebrahim, T. Y. (2020). Artificial intelligence inventions & patent disclosure, *Penn St. L. Rev.*, 125, 147. https://elibrary.law.psu.edu/pslr/vol125/iss1/4

44 PCT/IB2019/057809 (Thaler, Stephen L.), filed Sept. 17, 2019.

45 In July 2021, South Africa issued a patent in the DABUS case without conducting a substantial examination of the patent application.

46 A more detailed analysis of the case law is available in SCP/35/7 Artificial Intelligence (AI) and Inventorship, https://www.wipo.int/meetings/en/doc_details.jsp?doc_id=620584. Document SCP/35/7 outlines the decisions of IP offices and courts from Australia, Brazil, Canada, Germany, India, New Zealand, the Republic of Korea, South Africa, the United Kingdom, the United States of America and the European Patent Office.

47 Article 33, TRIPS Agreement (TRIPS: Agreement on Trade-Related Aspects of Intellectual Property Rights, April 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994)) states that "[t]he term of protection available shall not end before the expiration of a period of twenty years counted from the filing date." This sets a minimum duration, although this can vary according to the jurisdiction and the type of patent and invention.

48 Article 27, TRIPS Agreement.

49 IP Australia (2023). *Generative AI and the IP Rights System*. Canberra: IP Australia https://www.ipaustralia.gov.au/temp/Generative-AI-and-the-IP-System.html

50 This approach would also accommodate AI-assisted inventions which could then name a human and an AI system as co-inventors.

51 This approach has been suggested by the German Federal Patent Court in the DABUS case as a potential way forward. While the German Federal Patent Court maintained that the named inventor must be a natural person even for AI-generated inventions, the Court suggested that a patent application may expressly note the involvement of the AI system. See The Bundespatentgericht/Federal Patent Court, Case 11 W (pat) 5/21, decision of Nov. 11, 2021, EC LI:DE:BPatG:2021:111121B11Wpat5.21.0 − Food container. See discussion in Kim, D. (2022). The paradox of the DABUS judgment of the German Federal Patent Court, *GRUR International*, 71, 1162. For a translation of the judgment, see Felmy, A. (2022). Filing a patent for an AI-generated invention, *GRUR International*, 71, 1185.