



November 11, 2019

The Honorable Andrei Iancu
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office
P.O. Box 1450,
Alexandria VA 22313-1450

Via email: AIPartnership@uspto.gov

Re: Comments on Patenting Artificial Intelligence Inventions

Dear Director Iancu:

Intellectual Property Owners Association (IPO) submits the following comments and suggestions in response to the USPTO’s notice entitled “Request for Comments on Patenting Artificial Intelligence Inventions,” published in 84 Fed. Reg. 44889 (Aug. 27, 2019).

IPO is an international trade association representing companies and individuals in all industries and fields of technology who own, or are interested in, intellectual property rights. IPO’s membership includes 175 companies and close to 12,000 individuals who are involved in the association either through their companies or as inventor, author, law firm, or attorney members. IPO advocates for effective and affordable IP ownership rights and provides a wide array of services to members, including supporting member interests relating to legislative and international issues; analyzing current intellectual property issues; information and educational services; and disseminating information to the general public on the importance of intellectual property rights.

IPO agrees that artificial intelligence inventions will only continue to become more important to a wide range of technologies and supports the USPTO’s exploration of whether existing intellectual property law and policy create the proper incentives and rewards to support inventors in this area. We appreciate the ability to provide feedback and look forward to future opportunities to continue this discussion. Our answers to each of the questions posed in the request for comments are below. Note that each of our responses discusses AI in the context of the current state of the technology and that perspectives might change with the eventual development of Artificial General Intelligence.

1. Inventions that utilize AI, as well as inventions that are developed by AI, have commonly been referred to as “AI inventions.” What are elements of an AI invention?

This and the remaining questions use the term “AI inventions” to encompass two distinct categories: Inventions that utilize AI and inventions that are developed by AI. For clarity, we suggest using the term “AI-related inventions” instead of “AI inventions.” Our comments refer to inventions that utilize AI as Application Specific AI inventions, to inventions that are developed by AI as AI Generated inventions, and add the category of Core AI inventions, all of which are defined hereinafter.

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Core AI inventions are technologies that have general applicability (*i.e.*, are not limited to specific problem domains) such as new types of AI architectures and methodologies. Core AI also includes hardware-based AI technology such as AI accelerator chips, neuromorphic chips, and improvements in graphics processing units (GPUs).

Application Specific AI inventions employ Core AI technologies as one component in a larger context to perform tasks more intelligently. In other words, this type of AI-related invention applies one or more Core AI technologies to a specific problem or task domain. Application Specific AI inventions typically integrate the Core AI technologies with domain specific systems that provide input data (*e.g.*, sensors) or use the outputs of the Core AI technology for a specific end goal (*e.g.*, to control the path of a robot).

AI Generated inventions are products, designs, processes, computer programs, or other types of material artifacts that are designed in whole or in part by an AI system. The resulting material artifacts may or may not relate to AI.

Because of the significant differences among these categories of AI-related inventions, there is no one set of elements common to all AI-related inventions. Due to the diversity of implementation and application, identifying the range of possible elements in each category of AI-related inventions would require a lengthy and detailed treatment that is not likely to be valuable in the context of this question. Further, an attempt to distill common elements of all AI-related inventions would necessitate creating broad general features that are not beneficial to understanding the differences between AI-related inventions for considering issues such as inventorship, enablement, eligibility, non-obviousness, and so forth.

Nevertheless, we discuss and provide examples regarding elements of the above categories of AI-related inventions for clarity. The elements depend on the subtype of AI being used and the application domain in which the AI is deployed.

Core AI inventions: Elements depend on the subtype of AI technology being considered. Thus, the elements of a new type of artificial neural network (ANN) architecture will be different from the elements of a new type of expert system, evolutionary algorithm, or AI accelerator chip.

Given the current interest in neural networks (NN) and machine learning (ML), the following features may be part of a Core AI invention for a new NN architecture:

- General objective, such as classification, prediction, translation, content generation
- Data representation and pre-processing
- Node (“neuron”) definition (internal structure, activation function, output function)
- Layer definitions, including layer function (*e.g.*, input, convolution, normalization, pooling, hidden layer, output layer, etc.), layer shape and interconnectivity, organization and sequencing of layers
- Hyperparameters, optimization, regularization, loss function, training algorithm.

This list is illustrative and not meant to suggest that every feature must be expressly discussed in a patent application for a NN architecture. Rather, the list identifies various aspects of a NN architecture that may be part of a Core AI invention.

Example: A training technique that vastly reduces the training time of ML models for very-high-dimensionality data sets, such as population-wide medical studies, by using a new loss function and training algorithm. The ability to train or retrain ML models rapidly may be extremely important, such as where conventional training models require significant amounts of time to complete even on the fastest supercomputers, and where the new training process may complete the same training within several hours. This training technique is an improvement in the functionality of the ML model. The elements of the AI-related invention here would be the loss function and the steps of the training algorithm and the selection of the relevant hyperparameters.

Application Specific AI inventions: Elements can be similar to those of Core AI but parameterized for a particular application domain.

Example: A factory assembly line including a machine vision system that visually inspects a manufactured part for defects. The system is configured to inspect the part for potential defects using infrared and ultraviolet light at a point in the manufacturing process during which the part is not visible to humans, such as within a mold, where early detection may permit an adjustment of the manufacturing process that compensates for the defect and salvages the part. In this example, the machine vision system includes a conventional convolutional NN that is trained in a typical manner to detect a simple feature, such as color, shape, orientation, or alignment of the part. The training data is specific to infrared and ultraviolet images of the part being manufactured under various conditions, and the output layer is configured to provide a classification signal as to the type of defect. Thus, the ML component is integrated into a specific application using domain specific data to provide domain specific outputs.

AI Generated inventions: Elements depend on what its invented. For instance, if the invention is a beverage container, the elements will be associated with the beverage container (*e.g.*, shape, material, etc.). If the invention relates to an improvement in AI, the elements will be associated with Core AI inventions described above. There are no elements specific to the fact that the invention was generated by AI as opposed to a human.

Example: A protein that binds to a receptor in a certain type of virus to provoke an immune system response. The selection of the protein may involve the simultaneous consideration of many properties, such as the shape and physical chemistry of the amino acid sequence that exclusively binds to this receptor; the synthesis pathway to produce this protein from a DNA sequence; and compatibility with other pharmaceuticals. The protein may be primarily or even solely designed by a conventional ML algorithm; however, the elements of the claimed invention would be directed to the structure of the protein itself, without regard to the manner in which it was identified by the ML system.

2. What are the different ways that a natural person can contribute to conception of an AI invention and be eligible to be a named inventor? For example: Designing the algorithm

and/or weighting adaptations; structuring the data on which the algorithm runs; running the AI algorithm on the data and obtaining the results.

The established rules of inventorship and conception can be applied to AI-related inventions in a straightforward fashion. “The threshold question in determining inventorship is who conceived the invention” as claimed in a patent. *See* MPEP 2137.01 (citing *Fiers v. Revel*, 984 F.2d 1164, 1168 (Fed. Cir. 1993)). Conception is “the formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention as it is thereafter to be applied in practice....” *See* MPEP 2138.04 (citing *Townsend v. Smith*, 36 F.2d 292, 295 (CCPA 1930)). This definition is readily applied to people developing inventions related to AI. (Note: this question does not raise, and we do not address, whether an AI system itself can be an inventor.)

Applying the three categories of AI-related inventions from our response to Question 1, there is nothing unique about how a natural person contributes to the conception of an AI-related invention versus any other highly technical field.

Core AI inventions: The inventive contributions of AI researchers or data scientists developing new AI systems or improving existing AI systems are significant human activities that can be analyzed under existing conception law as applied to highly technical arts such as the computer and software arts. This category fits the example of “designing the algorithm” recited in Question 2. A person (such as an AI researcher or data scientist) who contributes to the design of an AI algorithm that is the subject matter of a patent claim is eligible to be a named inventor on the patent.

Application Specific AI inventions: Inventors integrating AI components into larger systems are also readily analyzed under existing conception law because they will involve a significant human effort to apply AI techniques to a new problem. This might involve people performing the Question 2 example activities of “weighting adaptations,” “structuring the data” used by the AI algorithm, or running the AI algorithm on data and obtaining results. Such a person is eligible to be a named inventor on the applicable patent provided that such activities lead to a subject matter contribution of at least one claim of that patent.

AI Generated inventions: Like other forms of technology, AI should be viewed as a tool that can help human inventors through the research and development process to create new products ranging from simple objects such as furniture to complex structures such as airplane parts, as well as new materials and pharmaceuticals. The process of using AI to solve a problem is technically challenging due to the work involved in selecting the appropriate AI model, setting up the AI model, selecting and preprocessing suitable training data, training the system, etc. Thus, setting up an AI system to solve a problem and then reviewing the results to confirm their efficacy would provide acts of conception. As with prior examples, the specific activities mentioned in Question 2 (*e.g.*, weighting adaptations; structuring the data on which the algorithm runs; and running the algorithm on the data and obtaining results) illustrate human activities that might demonstrate a human’s contribution to the conception of a claimed AI-related invention.

There may come a time when a human can provide an AI system a description of a desired result (*e.g.* “design a material having the following properties...”) and the AI system will independently determine how to obtain it. This is what is known as Artificial General Intelligence (AGI), which does not yet exist. But even if technology sufficiently advances to accomplish a task with little human intervention, it can also be evaluated under existing law. One could view the human invoking AI to solve a problem like a manager giving an assignment to a subordinate. *See Ex parte*

Smernoff, 215 USPQ 545, 547 (Bd. App. 1982) (“one who suggests an idea of a result to be accomplished, rather than the means of accomplishing it, is not a coinventor”).

If a human uses AI to solve a problem by defining a result without providing input as to the means of accomplishing it, the human does not contribute to conception and could not be an inventor. That said, it seems more likely that an AI system would be used interactively by a human to iteratively explore design alternatives, with the human specifying initial design constraints and the AI system producing a set of initial results or data based on such constraints. The human would then refine the constraints, and the AI system would produce an updated set of design solutions; this process would repeat until a suitable result is obtained—one likely selected by the human. In this scenario, the human would be an inventor of the final product. We express no opinion on whether the AI system in this scenario could or should be considered an inventor.

3. Do current patent laws and regulations regarding inventorship need to be revised to take into account inventions where an entity or entities other than a natural person contributed to the conception of an invention?

AI systems can be powerful tools to help conceive and implement inventions. The use of AI-based tools may aid a natural person, just as tools in other technical fields aid humans in the conception of inventions.

Under current law in the United States and elsewhere, inventors cannot be non-natural persons. *See Report from the IP5 Expert Round Table on Artificial Intelligence* at 1-2 (Oct. 31, 2018), https://www.fiveipoffices.org/wcm/connect/fiveipoffices/5e2c753c-54ff-4c38-861c-9c7b896b2d44/IP5+roundtable+on+AI_report_22052019.pdf?MOD=AJPERES&CVID= (“The IP5 Offices account for 80% of the global patent market. . . . all IP5 jurisdictions require that the inventor is a human being.”); *New Idea Farm Equip. Corp. v. Sperry Corp. & New Holland Inc.*, 916 F.2d 1561, 1566 n.4 (Fed. Cir. 1990) (“people conceive, not companies”).

Taking the contrary position that something other than a natural person may be named as an inventor of an AI system would require changing U.S. patent law and regulations. Likewise, expanding the definition of “inventor” to include non-natural entities would require changing additional laws and regulations. For example, an inventor is required to make a declaration stating that s/he “believes himself or herself to be the original inventor or an original joint inventor of a claimed invention in the application.” 35 U.S.C. 115(b)(2). Declarations under 37 CFR §1.63 require that:

(c) A person may not execute an oath or declaration for an application unless that person has reviewed and understands the contents of the application, including the claims, and is aware of the duty to disclose to the Office all information known to the person to be material to patentability as defined in §1.56. There is no minimum age for a person to be qualified to execute an oath or declaration, but the person must be competent to execute, i.e., understand, the document that the person is executing.

* * * *

(f) An oath or declaration under this section, including the statement provided for in paragraph (e) of this section, must be executed (i.e., signed) in accordance either with § 1.66 or with an acknowledgment that any willful false statement made in such declaration or statement is

punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

37 CFR § 1.63 (c), (f) (emphasis added). Amendments would be required to address how (or even whether) a non-natural entity, such as an AI system, could make such statements.

The use of a “substitute statement” under 35 U.S.C § 115 (d) in lieu of executing a declaration does not fill the gap left by 35 U.S.C § 115(b)(2) because an AI system is not an “individual” who is “(i) deceased, (ii) is under legal incapacity; or (iii) cannot be found or reached after diligent effort; or (B) is under an obligation to assign the invention but has refused to make the oath or declaration required. . . .” 35 U.S.C § 115(d)(2). That an AI system cannot execute a declaration cannot be solved by a substitute statement.

If non-natural entities were afforded inventor status, additional downstream issues would also need to be addressed. For example, during an enforcement proceeding it would be impossible to depose an AI system concerning its contribution to determine whether it was properly listed as an inventor and what it meant by the use of terms in the specification and claims.

4. Should an entity or entities other than a natural person, or company to which a natural person assigns an invention, be able to own a patent on the AI invention? For example: Should a company who trains the artificial intelligence process that creates the invention be able to be an owner?

This question appears to presume that the “AI invention” at issue is an AI Generated invention, such as an improved toothbrush designed by an AI system, and thus the AI system is the “inventor.” See the response to Question 1 for a description of the various types of AI-related inventions. AI-related inventions not invented by the AI system itself that relate to improvements to AI systems or algorithms, applications of AI systems, and the initial development of a Core AI system, are presumed to be performed by humans and thus the human inventor is the original owner who can assign the invention to an appropriate entity.

Generally, a natural person who trains the AI process that creates an AI Generated invention should be able to be an owner. Similarly, a company that owns the process should be able to be an assignee of an invention. However, as discussed in the response to Question 3, current law does not allow an AI computer system to be a named inventor on a patent or to own an invention. There is therefore no mechanism by which the AI system can assign such an invention to a natural person or a company. Under current law, a human declares that they are the inventor and typically signs an assignment to a company because the human is the original owner of the invention. The obligation to assign is typically contractual through an employment agreement. U.S. law does allow for a “substitute statement” to be filed in lieu of executing a declaration, but that is only with respect to an “individual” who is “(i) deceased, (ii) is under legal incapacity; or (iii) cannot be found or reached after diligent effort; or . . . is under an obligation to assign the invention but has refused. . . .” 35 U.S.C § 115. There is no substitute statement exception for a non-human that cannot sign a declaration. Thus, assuming an AI system can truly conceive of or create an invention, changes in the law would be required to allow the AI system to be the inventor or original owner of the invention. Currently, under U.S. law only a human can be an original owner. Neither the Constitution nor U.S. law provide for such entities to have ownership rights. Many practical issues would need to be addressed to enable such an entity to own an invention and to deal with the

patenting process because an AI tool or system that invents something is not a natural person or a company.

A proposed framework for governing AI Generated Inventions within the context of the issues raised in Question 4 might include the following considerations:

1. Should there be a new type of declaration, or new substitute statement under MPEP 602.01, signed by a human certifying that the AI system generated the invention?
2. How can proof of inventorship by an AI system be provided for a patent filing which is the equivalent of a human declaration?
3. Can a contract be established between the developer, builder, user, and/or licensee of the AI system which governs who an original owner is of an AI invention?
4. Can a contract be established between the developer, builder, user, and/or licensee of the AI system which governs who has a contractual right to be assigned an AI invention?
5. If there are multiple copies of an AI system or algorithm that generates an invention, which copy would own the invention?
6. If an AI system can “own” an invention, how does that AI system get identified? By name? IP Address? Serial number?
7. If an AI system can “own” an invention (whether it created the invention or not), if the AI algorithm is deleted from memory or the system is damaged or destroyed, who owns the invention?
8. Who would get the money from licensing IP generated by an AI system?
9. Would the AI system have to generate any kind of declaration stating that its output is an “AI invention” relative to its training. In other words, would the AI system have to declare that its output is more than a rote or mechanical application of the trained AI algorithm?
10. Does a patent specification have to identify which elements of a claimed invention were generated or conceived by an AI system? Is there any specific statement that would need to be made or affirmation regarding the AI system contribution to the claimed invention?
11. In other countries, including the UK, the rights to an invention transfer from the employee to the employer under statutory provisions (*See, e.g.*, the UK Patents Act 1977). Should U.S. law be changed to adopt a similar statutory framework so that an AI system’s inventions (if any) transfer by law to the company that employs or owns the AI system (like U.S. Copyright laws for employee “work for hire” works are transferred to the applicable employer)?

Establishing a framework for AI systems to own IP or to enable the issuance of a patent “invented” by an AI system raises many issues not addressed by the current law.

5. Are there any patent eligibility considerations unique to AI inventions?

No. As discussed in the response to Question 1, AI-related inventions are a species of software (and in some cases hardware inventions, *e.g.*, AI “chips”). The same eligibility considerations that pertain to software (and hardware) pertain to AI-related inventions. That said, because AI-related

inventions are frequently characterized as systems that mimic human intelligence in performing cognitive tasks, they are more likely in practice to be subject to patent eligibility issues concerning “abstract ideas” and so-called “mental steps.”

The current USPTO procedure for evaluating subject matter eligibility is set forth in 2019 Revised Subject Matter Eligibility Guidance (01/07/19) (“2019 PEG”):

Step 1: Determine whether the claimed subject matter falls within the four statutory categories of patentable subject matter identified by 35 U.S.C. § 101: process, machine, manufacture, or composition of matter.

Step 2A:

Prong 1: Determine whether the claim recites a judicial exception. If not, claim is patent eligible. If so, proceed to Prong 2.

Prong 2: Determine whether the claim as a whole integrates the recited judicial exception into a practical application of the exception. If so, then the claim is patent eligible. If not proceed to Step 2B.

Step 2B: Determine whether the claim recites an “inventive concept.” If so, the claim is patent eligible. If not, the claim is ineligible.

Under Step 1, an AI-related invention can be claimed as a method, system/machine or article of manufacture, just like software, and will fall into a recognized statutory category. Some general examples include:

1. Process/Method claims: AI-related inventions may be claimed as methods, reciting a series of steps for processing data and producing an output.

These could include methods directed to the production of an AI-related invention (*e.g.*, methods for training a ML model, pre-processing input data, setting weights and biases or hyperparameters) and methods directed to deployment (*e.g.*, methods for classifying data, segmenting data, translating text, and so forth).

Where the AI-related invention is specific to a particular application domain (*e.g.*, driving an autonomous vehicle), the claim will typically recite domain specific data to be processed (*e.g.*, vehicle operation parameters and external information such as detected objects in the path of the vehicle) as well as domain specific outputs (*e.g.*, signals to control the braking, steering, and acceleration of the vehicle). Additionally, different application domains typically require distinctive types of computerized representation such as pixel values for images, word embeddings for text, or frequency domain decompositions for audio.

2. Machine/System/Apparatus claims: AI-related inventions may also be claimed as systems of components, which attempts to more generally capture the architecture of the AI system. System claims for NN-based AI may include elements such as layers of node (or “artificial neurons” or the equivalent), descriptions of connectivity between layers, and the functional operations performed by the nodes or layers.
3. Article of Manufacture claims: Many AI-related inventions are implemented in software and might be claimed as Beauregard (computer program product) claims, where the claim

elements are set forth as functional units (*e.g.*, modules, layers of nodes, etc.) stored on non-transitory computer readable medium. The use of Beauregard claims for AI-related inventions claimed in this fashion does not generally present unique issues for Step 1.

However, AI systems—particularly, but not exclusively ML systems—are distinct from other types of software in that they have both development (“training”) and production phases that can be carried out by entirely different entities or organizations. The development phase is typically the most time consuming and expensive and results in a trained system that can be used by others directly as an end product, or in some cases might be further trained for a specific application (this is called transfer learning and is becoming commonly employed, for example in natural language processing). Since the trained model has specific economic value, it is likely the USPTO will receive article of manufacture claims that recite a trained AI system, such as a trained ML model or a knowledge base of expert system rules that could raise the difficult issue of whether the claim is eligible under Step 1 in view of *Digitech Image Technologies, LLC v. Electronics for Imaging, Inc.*, 758 F.3d 1344 (Fed. Cir. 2014) (holding that a claim to a “device profile” with specific “data” did not fall into any of the statutory categories because “[d]ata in its ethereal, non-physical form is simply information that does not fall under any of the categories of eligible subject matter under section 101.”); *see also Allvoice Developments US, LLC v. Microsoft Corp.* 2014-1258 (Fed. Cir. May 22, 2015) (“Software may be patent eligible, but when a claim is not directed towards a process, the subject matter must exist in tangible form.”)

AI-related inventions are now commonly used in the field of generative design to help design (or even fully design) specific artifacts, ranging from simple objects such as furniture to complex materials and machines, to molecules or drugs. The resulting artifacts can be claimed as articles of manufacture or compositions of matter. The involvement of an AI system in the design of such artifacts does not impact the analysis under Step 1.

At Step 2A, the primary issue for AI-related inventions, as with software generally, is whether a claim to an AI-related invention is directed to an “abstract idea.” Just as software-based inventions are not *per se* abstract ideas, AI inventions are also not *per se* abstract ideas. Rather, whether a claim for an AI-related invention is directed to an abstract idea will depend on the subject matter claimed and the manner of claiming.

The response to Question 1 set forth a general taxonomy for AI-related inventions. We use that taxonomy here to provide the following observations:

Application Specific AI inventions: The most general category of AI-related inventions is that in which an AI system is applied to provide a human (or super-human) level of performance for a domain specific task in response to domain specific data. The question under Step 2A will be whether a claim directed to an AI method or system that performs a particular task is directed to an abstract idea.

Under the 2019 PEG, such a claim will generally not be directed to an abstract idea under Step 2A, Prong 1. Example 39, provided with 2019 PEG, is a claim for training a NN for facial detection. The analysis states that the “claim does not recite any of the judicial exceptions enumerated in the 2019 PEG.” The example claim is limited to a specific task (training the NN for detecting images of human faces), and all the claim limitations recite specific data (*e.g.*, digital facial images) and image processing operations on such data. The USPTO concludes that the claim does not recite any of the judicial exceptions (mathematical algorithms, mental steps, organization of human activity or

fundamental economic concepts). This suggests that, generally, claims to specific applications of AI are not directed to abstract ideas.

Some claims for AI-related inventions might include limitations that are mathematical in nature—for example, claims reciting the use of combinations of activation functions, loss functions, or other computations. In these instances, the eligibility analysis will proceed to Step 2A, Prong 2, to determine whether the claim as a whole integrates the mathematical operation into a practical application. In general, where a claim recites the use of the mathematical operations for a particular purpose, such as classification, prediction, control, language translation, and so forth, these purposes serve as the “practical application” and thus the mathematical operation will be sufficiently integrated into a practical application. In other words, the claim is not directed to the mathematical operation divorced from a particular application. It should not be necessary to limit the claim to particular types of data (*e.g.*, facial images vs. radiological images). Rather, the practical application may be found at the level of the operation, such as training, classification, prediction, etc. But further limitations to specific fields (*e.g.*, analysis of “radiological images” as opposed to “images” generally, or control of “vehicle” as opposed to control of a “machine”) may provide further indicia of practical application and thus satisfy Prong 2.

AI Generated inventions: The use of AI systems in the design and creation of products is a rapidly developing field. AI systems are used for drug discovery, chemical engineering, material engineering, manufacturing, as well as product design, and numerous other commercial and industrial fields. AI systems reduce the time necessary to identify or evaluate potential products for their fitness for a particular purpose. This is especially beneficial in fields where a product or solution can be characterized by a large number of variables interacting in non-linear ways, such that the number of different possible designs (*e.g.*, combinations of variables) makes it practically impossible to evaluate each individually. ML systems are well suited for exploring a vast range of potential combinations of variables to identify potential candidates.

These types of inventions do not raise issues by virtue of being produced by an AI invention. The resulting product will typically be a physical artifact (or a process for designing or manufacturing the artifact) and as such will not recite a judicial exception under Step 2A, Prong 1, or at will least recite the integration of a judicial exception (*e.g.* a mathematical algorithm describing some feature of the physical artifact) into a practical application (the physical artifact).

Core AI inventions: The core of any AI or ML system is the underlying “model” of representation and processing. In a NN-based ML system, the architecture includes the arrangement of various types of nodes (or “cells”) such as input, hidden, memory, and output nodes, characterized by specific patterns of interconnections between nodes, as well as particular functional operations for activation or training. The details of individual nodes or cells varies as well (*e.g.*, activation functions, convolution operations, pooling, etc.). Other types of AI/ML systems, such as decision trees, support vector machines, expert systems, genetic algorithms, etc. each have their own specific architectures and functional operations.

In any AI/ML system, the underlying implementation is data structures in computer memory coupled with code that executes mathematical operations. Accordingly, core AI inventions typically claim improvements in structural or functional features that result in reduced memory requirements (*e.g.*, reducing the number of parameters to be learned), reduced training time or computational requirements, or increased accuracy of the system for the given task. The improvement (*e.g.*,

“reduction of training time”) need not be expressly stated in the claim since it is a result of structural or functional aspects of the system rather than a feature.

It could be argued that AI-related inventions generally, and particularly NN inventions, are inherently “abstract” because they perform “mental steps” similar to humans. This argument is premised on the characterization of AI as performing “cognitive” tasks in an “intelligent” manner. Indeed, NNs are inspired by or modeled on human neurons. Thus, some might argue that AI performs mental steps, and that therefore a claim to an AI-related invention is directed to an abstract idea. The argument would then assert that claims to core AI-related inventions that “only” speed up the operation of the computer or reduce memory requirements or increase accuracy only improve upon an already abstract process, and thus lack an inventive concept. Similarly, because limiting a judicial exception to a technological field is insufficient to provide an “inventive concept,” claims to specific applications of AI-related inventions might be argued to lack an inventive concept.

This argument is based on misconceptions about the nature of AI-related inventions and NN implementations in particular. First, the argument conflates the goal or objective of an AI-related invention to operate with apparently human-like “intelligence” with the actual implementation, the actual structural and functional design of such systems. The argument assumes that because the “result” of an AI-related invention is ostensibly intelligent behavior, the underlying operation is the same or similar to how a human performs the operation. What matters for patent eligibility is not the result (which cannot be the basis of eligible subject matter) but the claimed structure or function that achieves the result. In that regard, AI-related inventions typically are implemented in the same manner as other types of software (or hardware), which bear no resemblance to the structure or operation of the human mind.

Second, the argument confuses metaphors and anthropomorphic descriptions used to explain how AI operate with how they are implemented. Metaphorical and anthropomorphic descriptions are frequently used to describe AI to laymen and novices. For example, consider the following excerpt from *A Beginner's Guide to Generative Adversarial Networks (GANs)*

Meanwhile, the generator is creating new, synthetic images that it passes to the discriminator. It does so in the hopes that they, too, will be deemed authentic, even though they are fake. The goal of the generator is to generate passable hand-written digits: to lie without being caught.

...

You can think of a GAN as the opposition of a counterfeiter and a cop in a game of cat and mouse, where the counterfeiter is learning to pass false notes, and the cop is learning to detect them. Both are dynamic; *i.e.*, the cop is in training, too (to extend the analogy, maybe the central bank is flagging bills that slipped through), and each side comes to learn the other’s methods in a constant escalation.

A.I. WIKI, <https://skymind.ai/wiki/generative-adversarial-network-gan> (last visited Nov. 11, 2019).

Describing a GAN as having “hope” and attempting to “lie” or behaving like a cop or a counterfeiter might make it easier to understand what the GAN is doing but is irrelevant to how a GAN operates. Technical literature on AI typically avoids metaphors and anthropomorphic descriptions, which are irrelevant to skilled artisans and do not convey useful technical details.

But there are certain types of AI that more directly model human “mental steps,” specifically expert systems. The mental steps doctrine grew out of decisions by the Court of Custom and Patent Appeals where the claimed invention required human judgment, but not where the claimed invention was disclosed as implemented by a computer. *See In re Heritage*, 150 F.2d 554 (C.C.P.A. 1945) (claims for making coated fiber board ineligible where they were “essentially directed to a purely mental process of making a selection of the amount of coating material to be used in coating a porous fiber board”); *In re Abrams*, 188 F.2d 165 (C.C.P.A. 1951) (claims were ineligible mental steps where no specific apparatus or machine was disclosed for performing the steps, thus requiring human performance); *In re Yuan*, 188 F.2d 377 (C.C.P.A. 1951) (relying on *Abrams*, claims were ineligible mental steps where no specific structure disclosed); *In re Prater* 415 F.2d 1393 (C.C.P.A. 1969) (claim for computer implemented process were eligible where “Disclosure of apparatus for performing the process without human intervention may make out a prima facie case that the disclosed process is not mental and is, therefore, statutory.”); *In re Bernhart* 417 F.2d 1395 (C.C.P.A. 1969) (claims to computer implemented process eligible where claims recited conventional computer elements) (“Looking then to method claim 13, we find that it in no way covers any mental steps but requires both a "digital computer" and a "planar plotting apparatus" to carry it out.”).

The mental steps doctrine has been dramatically expanded by the Federal Circuit. Even so, the court still seems to focus on claims where the steps performed by the computer are claimed at a high enough level of generality that they correspond to the steps a human would or could perform. *See SmartGene, Inc. v. Advanced Biological Laboratories, SA*, 2013-1186 (Fed. Cir. Jan. 24, 2014) (claims to medical expert system ineligible where “every step is a familiar part of the conscious process that doctors can and do perform in their heads”); *Intellectual Ventures I LLC v. Symantec Corp.*, 2015-1769 (Fed. Cir. Sept. 30, 2016) (claims to rules-based spam and malware detection ineligible because “there is nothing in the claims themselves that foreclose them from being performed by a human, mentally or with pen and paper”); *Return Mail, Inc. v. USPS*, 2016-1502 (Fed. Cir. Aug. 28, 2017) (claims to providing address correction information to a sender of undeliverable mail ineligible because “Encoding and decoding mail recipient information—including whether the sender wants a corrected address—are processes that can, and have been, performed in the human mind.”).

By design, expert systems attempt to replicate human decision making using the types of “rules” human experts use. These rules and facts about the domain are encoded into a “knowledge base” and are processed using the same logical operations that a human would use. Thus, to the extent a claim for an expert system recites steps or operations that a human would perform, it would recite a judicial exception under Step 2A, Prong 1 (it may still be patent eligible by satisfying the requirements of Step 2A Prong 2, or Step 2B).

Concerning the argument that ANNs perform mental steps, it is important to understand that although they are modeled on human neurons, there are significant structural and functional differences between ANNs and human brains, including differences in how they are interconnected and how neurons process inputs. *See generally The differences between Artificial and Biological Neural Networks*, TOWARDSDATASCIENCE.COM, <https://towardsdatascience.com/the-differences-between-artificial-and-biological-neural-networks-a8b46db828b7> (last visited Nov. 11, 2019). For example, ANNs use various types of “activation functions” to generate outputs from the input signals, such as ReLu, sigmoid, and tanh; biological networks do not use these mechanisms but rely on complex chemical signaling provided by neurotransmitters across the synaptic connections

between neurons. Equally important, ANNs “learn” using algorithms including gradient descent and back-propagation, rather than by recalling prior information. Humans learn by recalling information, such that the underlying neural networks forming new interconnections. This does not occur in ANNs, where the connections are fixed by design. Thus, although ANNs might use mathematical functions to model or simulate how real neurons work, they do not operate in the same manner as real neural networks.

An ANN does not perform steps that correspond to the kind of high level “mental steps” that the doctrine is meant to exclude. Rather, whatever “intelligence” is demonstrated by an ANN is a supervenient property or result of these lower level operations. Thus, claims to specific implementations of features of ANN or other ML inventions should not generally be considered directed to mental steps.

Finally, the argument that claims for AI-related inventions and especially ML-based AI are directed to mathematical algorithms because they are simply complex arrangements of mathematical functions (*e.g.*, matrix multiplication) or numerical data simply proves too much. All software applications—and indeed all digital hardware—operates at the lowest levels by performing mathematical operations. Neither the USPTO nor the federal courts have accepted this as a basis for ineligibility of software-based inventions, nor should they for AI-related inventions.

6. Are there any disclosure-related considerations unique to AI inventions? For example, under current practice, written description support for computer-implemented inventions generally require sufficient disclosure of an algorithm to perform a claimed function, such that a person of ordinary skill in the art can reasonably conclude that the inventor had possession of the claimed invention. Does there need to be a change in the level of detail an applicant must provide in order to comply with the written description requirement, particularly for deep-learning systems that may have a large number of hidden layers with weights that evolve during the learning/training process without human intervention or knowledge?

No. First, 35 U.S.C. § 112(a) does not set forth different written description standards for different technical fields. This represents a legislative choice to establish a unitary standard for all fields of technology. Second, the USPTO has published examiner training materials that guide the application of the § 112(a) written description requirement for computer-implemented inventions, which includes the following principles:

Slide 21 (“Written Description - Programmed Computer Functions”): “Computer-implemented inventions are often disclosed and claimed in terms of their functionality because writing computer programming code to perform specific functions is normally within the skill of the art once those functions have been adequately disclosed. ... While disclosure of the program code is not required, the detailed steps or instructions that the program follows should be described.”

Slide 30 (“Written Description Summary”): “An original claim may lack written description when the claim defines the invention in functional language specifying a desired result but the specification does not sufficiently identify how the function is performed or result is achieved. For programmed computer functions, determine whether the specification discloses in adequate detail the computer and the algorithm (*e.g.*, the necessary steps and/or flowcharts) that perform the claimed function.”

These principles are similarly applicable to AI-related inventions as to conventional algorithmic solutions. Consequently, there appears to be no need for further clarification of this requirement in the context of AI-related inventions. Moreover, any clarification would likely create a legal distinction in the written description requirement for AI-related inventions, which, as previously noted, would could result in a subjective and fact-specific determination.

This question seems to imply that the written description standard should vary for “deep-learning systems that may have a large number of hidden layers,” but the basis for this implication is unclear. For the purpose of the § 112(a) written description requirement, as long as “the specification describes a claimed [AI-related] invention in sufficient detail that one skilled in the art [of artificial intelligence] can reasonably conclude that the inventor had possession of the claimed invention at the time of filing,” *LizardTech, Inc. v. Earth Res. Mapping, Inc.* 424 F.3d 1336 (Fed. Cir. 2005), the legal standard has been satisfied. That requirement is satisfied by describing the relevant architectural and functional aspects of an AI-related invention. For example, in contemporary advances in deep learning, the number of layers is of less technical significance than the types and functionality of such layers. For instance, the technical advance of the ResNet deep CNN (up to 152 layers) over the AlexNet deep CNN (8 layers) is not the number of layers, but the inclusion of skip connections that may address the issue of vanishing gradients. A description of a specific ML architecture, such as the number or arrangement of layers, is required only where those details would need to be explained to a person skilled in the art to establish possession of the invention by the applicant.

Furthermore, in other fields of technology applicants may present inventions of varying size or complexity (*e.g.*, the number of lines of code in an algorithm, the number of base pairs in a DNA sequence, or the number of transistors in a circuit). It has not been suggested that the written description requirement should be modified based on such factors.

This question also refers to “hidden layers with weights that evolve during the learning/training process without human intervention or knowledge” as potentially affecting (and, as implied, raising) the written description standard for ML inventions. However, the manner of choosing weights and biases in the layers of a NN is well-understood in the art. The use of activation functions, cost functions, backpropagation, gradient descent, and so forth is well-studied and readily known to practitioners.

Again, in other fields of technology, practitioners routinely utilize tools to generate complete, low-level specifications “without human intervention or knowledge.” For example, software developers use compilers to translate high-level programming languages into architecture-specific, machine-language instructions, and electrical engineers use hardware description language (HDL) design tools to generate transistor-level schematics from component-level descriptions. Yet, it has not been suggested that the ordinary use of automated tools could affect the written description requirement in these fields. On the contrary, one skilled in the art of ML would recognize the use of existing training algorithms as a familiar, well-understood step in the generation of a ML model—one that does not, *per se*, require additional disclosure to satisfy the written description requirement beyond the standard articulated in cases such as *LizardTech. Id.*

Artificial intelligence is just one example of technology accelerating at unprecedented speed. Accordingly, the capabilities of a person of ordinary skill in the art continue to advance and must be taken into account when applying § 112(a). The USPTO’s efforts to promote and maintain the level of understanding of examiners concerning the state of the art in AI, to maintain parity with the

current technical level of persons of ordinary skill in the art for applying tests such as § 112(a), is important for ensuring accurate and efficient examination and prosecution of inventions in this area. Given the applicability of AI to a wide range of technical fields, the USPTO might wish to promote training of examiners in a correspondingly broad range of art units that could handle applications for AI-related inventions.

7. How can patent applications for AI inventions best comply with the enablement requirement, particularly given the degree of unpredictability of certain AI systems?

The level of detail an applicant must provide to comply with the enablement requirement is the same for AI-related inventions and non-AI-related inventions. First, 35 U.S.C. § 112(a) does not establish different enablement standards for different technical fields. This represents a legislative choice to establish a unitary standard across all fields of technology. Second, the Office has published examiner training materials that guide the application of the § 112(a) enablement requirement for computer-implemented inventions, which include the following principles:

Slide 6 (“Satisfying the Enablement Requirement”): “Enablement can be shown by disclosing at least one method for making and using the claimed invention that bears a reasonable correlation to the entire scope of the claim. The specification need not contain an example if the invention is otherwise disclosed in such a manner that one skilled in the art will be able to practice it without an undue amount of experimentation. The specification need not teach what is well-known in the art.”

Slide 8 (“Enablement - Computer-Implemented Functional Limitations (Continued)”: “For software related inventions, the knowledge in the state of the art and predictability tends to be high. ... [I]f (1) the application fails to disclose any program and (2) more than routine experimentation would be required of one skilled in the art to generate such a program, the examiner would have a reasonable basis for challenging the sufficiency of such a disclosure.”

These principles apply to AI-related inventions as they apply to conventional algorithmic solutions. There appears to be no need for further clarification. Moreover, clarification would create a legal distinction in the enablement requirement for AI-related inventions, which as previously noted could require a subjective and fact-specific determination.

This question refers to a “degree of unpredictability of certain AI systems.” The values of parameters resulting from the training of a ML model (*e.g.*, weights and biases in a NN) may vary, but that variance does not render the AI system unpredictable in its training and functionality. On the contrary, data scientists have articulated a large number of principles about the behavior of trained ML systems as part of the fundamental theory of ML, such as the capabilities of models of varying properties and complexity to generalize from training data to parameters and functions that may be applied to new data. This research has produced heuristics, and in many cases quantitative boundaries, of ML techniques such as accuracy, confidence, and rates of training progress. The variability of training is therefore a well-understood, and often predictable and measurable, aspect of ML that does not rise to the level of “unpredictability” that may apply to technical fields such as chemistry.

Further, to the extent that generating a satisfactory ML model based on a disclosure of the model requires multiple training attempts, that aspect does not cause a lack of enablement in the disclosure. Failure to enable a claim under § 112(a) occurs only if “the experimentation needed to

practice the invention [is] undue or unreasonable.” See *In re Wands*, 858 F.2d 731, 737 (Fed. Cir. 1988). As long as the disclosure of an AI-related invention does not require undue or unreasonable experimentation to implement, taking into account the level of one of ordinary skill in the art of data science and ML—which is advanced and continuously advancing—the disclosure satisfies the § 112(a) enablement requirement.

8. Does AI impact the level of a person of ordinary skill in the art? If so, how? For example: Should assessment of the level of ordinary skill in the art reflect the capability possessed by AI?

The USPTO sets forth the procedure for resolving the level of ordinary skill in the art in the examination guidelines for obviousness. Namely, “[t]he person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. Factors that may be considered in determining the level of ordinary skill in the art may include: (1) “type of problems encountered in the art;” (2) “prior art solutions to those problems;” (3) “rapidity with which innovations are made;” (4) “sophistication of the technology; and” (5) “educational level of active workers in the field.” See MPEP 2141 (citing *In re GPAC*, 57 F.3d 1573, 1579 (Fed. Cir. 1995)). AI does not affect these factors for assessing the level of ordinary skill in the art.

The “capability” of AI tools or systems does not uniquely impact the level of a person of ordinary skill in the art. The “capability possessed by an AI” is not the kind that relates to “skill” at conceiving of inventions. AI tools are essentially no different from other types of software or hardware inventions. Their capability is improved performance in terms of speed or accuracy for solving complex problems. To equate this “capability” with “skill in the art” is to confuse the performance of a machine with the knowledge required to create that machine. We would not say a computer chip that performs calculations faster than humans has an impact on the level of skill in the art of computer chip design, nor would we say that a machine that makes pencils has an impact on the level of skill in the art of pencil making. Similarly, although an AI for diagnosing medical conditions may be able to out-perform human physicians in diagnosis, it cannot itself design an AI system for medical diagnosis.

Although an AI system may be able to perform a specific task at superhuman “level of skill,” this level of skill is only within the application domain itself (*e.g.*, a level of skill at playing Go or making medical diagnoses). An AI system can only perform its intended task; it cannot itself design a system that performs the same task. This is distinct from the level of skill in the art of designing an AI system.

To the extent that the application domain of an AI system is the design of AI systems, the level of skill of such an AI system only contributes to the “level of skill in the art” to the extent that the methodologies and outputs created by such a system can be systematically explained. Meaning, they can be taught and communicate to humans knowledge and skills in the art. Otherwise, an AI system would remain an uninterpretable “black box” and whatever capability it has would not “impact” the level of skill in the art.

In summary, what impacts the level of skill in the relevant art in which an AI system is deployed is publicly available disclosures of the underlying knowledge that led to the creation of the AI system—patents, technical papers, text books, code resources and so forth—the same resources used in any other field of technology.

9. Are there any prior art considerations unique to AI inventions?

No. 35 U.S.C. §§ 102 and 103 do not set forth different standards for different technical fields, and what constitutes prior art should not differ for software, including ML and other AI-related inventions. Nor should a heightened standard be created.

Given the potential applicability of AI-related inventions across many different fields, patent applications involving AI might be assigned to art units unfamiliar with AI. Proper training should be provided to USPTO examiners to ensure adequate prior art searching and the appropriate consideration of AI-related prior art across these different fields. Publicly available AI resources openly developed and supported by the AI community could be leveraged for both examiner training and as sources of prior art, including OpenAI, gitHub, Google AI, and more.

10. Are there any new forms of intellectual property protections that are needed for AI inventions, such as data protection?

Current trade secret, patent, and copyright laws and regulations provide protections for AI-related inventions in the same manner as any software or hardware related invention. However, for certain innovations, such as data or select AI models, additional IP protections may need to be considered. We address this question from two perspectives: IP protection for the AI tool that embodies an AI invention and IP protection for subject matter created by the AI tool.

By way of example, AI tools directed to ML are embodied in a combination of software code implementing algorithm(s) and corresponding initial coefficients to form an “untrained model” of a task that normally requires human intelligence. A “trained model” starts with the same “untrained model” (same software code) and adjusts the algorithmic coefficients of the model based on a large data set applicable to the specific task (*e.g.*, untrained model for image recognition of a sick person from images of other persons, animals or inanimate objects).

Trade secret protection

If the AI tool (including the AI model itself) or data is kept as a trade secret, trade secret laws are applicable for protection. Likewise, current trade secret laws may be used to protect any derived data or additional software code created by the AI tool (or AI model) that can be kept trade secret.

Copyright protection

If the AI tool (such as an AI “untrained model”) is an original work fixed in a tangible medium, current copyright law provides the same level of protection as any software program and provides protection of the AI “trained model” tool for a specific application as a derivative copyrightable work. Data or additional software code (if any) created by the AI tool or AI model can also be protected as a derivative copyrightable work (assuming it is an original work fixed in a tangible medium).

Although a computer is not a person, to the extent that current U.S. copyright law treats the copyrightable work of an “employee” as a “work for hire” owned by his/her “employer,” copyright law could be extended to cover a computer hosting an AI model as also “employed” by the company that owns and operates the computer and AI model. In fact, the three factors identified by the Supreme Court in *Community for Creative Non-Violence v. Reid*, 490 U.S. 730 (1989) (1. Control by the employer over the work; 2. Control by employer over the employee; and 3. Status and conduct of the employer), can be relied on to confirm that a computer hosting an AI model

could be considered an “employee” for purposes of attributing an AI model as a “work for hire” under U.S. copyright law.

The idea or function of AI models and select data forms (such the numerical AI weights stored in a file or metadata that is factual) are not protectable under copyright law. In particular, certain compilations or arrangements of AI data in a database or file might have copyright protection when fixed in a tangible medium. But the data values themselves would not be protected. So any different compilation or arrangement of the same data may not be considered a derivative work, and the otherwise potential infringer could even have copyright protection in the different compilation or arrangement. This may drive the need for some form of sui generis IP protection for select data forms where the AI tool algorithms or model may be reverse engineered from the applicable select data form. Accordingly, trade secret or patent law/regulations may be currently the broadest form of protection for certain AI innovations. (Quite possibly, in some cases parties resort to reliance on contractual protections.) This might require the USPTO and Congress to consider alternative forms of IP in the future.

Patent protection

Patent protection can be utilized for inventions related to the AI tool (including an AI “untrained model”) and use of the AI tool across many ubiquitous technical areas provided that practical applications result (such as an AI “trained model”). In particular, subject matter created by the AI tool that may be viewed as an improvement (novel and not obvious) will be owned by the user or owner of the AI tool that applied the AI tool to a problem or placed the AI tool in operation in a given environment for a particular application.

Certain clarifications in U.S. patent law might help avoid ambiguities as to whether subject matter created by an AI tool is owned by the user or owner of the AI tool. For example, since other countries have analogous “work for hire” laws/regulations for ownership of the rights to a patent in that country (*e.g.*, as in the UK), U.S. patent law could be clarified to recognize an “employer” of an AI tool (untrained and trained) as the owner of the applicable rights (provided that all other inventors that contributed to the underlying invention assigned their rights to the employer as well).

11. Are there any other issues pertinent to patenting AI inventions that we should examine?

Examination guidelines should be crafted with the goal of promoting U.S. competitiveness in the global market. In recent years, uncertainty concerning the validity of software patents has been tied to the drop in U.S. patent filings and a general skepticism of software patents. At the same time, AI patent filings in other parts of the world have grown. For instance, China’s AI patent filings surged ahead of the U.S. in 2014. *WIPO Technology Trends 2019 - Artificial Intelligence* at 32, https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055.pdf. We encourage the USPTO to be wary of preemptively narrowing the scope of protection for AI-related inventions and disincentivizing AI development in the U.S.

In the past few years, some Art Units’ interpretations of section 101 examination guidelines have led to examiners encouraging claim amendments that could create divided infringement or detectability issues. Any guidelines specific to AI-related inventions should be drafted in a manner that does not cause issues in enforcement.

Should the USPTO pursue examination guidelines specific to AI-related inventions, transparency and predictability in implementing these guidelines will crucial. Guidelines should make clear that

examiners must conduct prior art searches. Otherwise, applicants will be required to respond to rejections based on examiners' personal judgment. Ensuring a prior art search will provide objectivity.

We suggest any new guidelines be applied prospectively to give applicants the chance to adjust their preparation and prosecution practices before examiners evaluate their applications based on the guidelines.

Finally, we suggest that AI-related invention specialists make quality checks to ensure consistency in the examining process across the USPTO. Some uncertainty related to the PEG arose from the lack of consistency between art units and sometimes between primary examiners' practices. AI-related invention specialists or AI-related invention quality control experts would help create a consistent approach that would add predictability to the patent application process.

12. Are there any relevant policies or practices from other major patent agencies that may help inform USPTO's policies and practices regarding patenting of AI inventions?

The EPO examination guidelines on AI appear to characterize ML as abstract or mathematical. EPO GUIDELINES FOR EXAMINATION, G-II 3.3.1. This approach is not helpful because it assumes the underlying framework of patent eligibility set forth in Article 52 of the European Patent Convention, which expressly excludes "mathematical methods." However, U.S. patent law does not. Further, not all ML inventions are properly characterized as merely mathematical concepts. Many advances in ML are based on architectural or functional differences rather than on new mathematical approaches.

The current USPTO guidelines do not automatically categorize a claim to a ML (or other AI system) as an ineligible abstract idea, but instead consider whether the claim recites a mathematical algorithm. Even if the claim recites a mathematical algorithm, the claim may still be eligible if the mathematical algorithm is integrated into a practical application. Thus, the EPO's blanket approach is not suited for use in the context of US patent examination.

Finally, we note that other major patent agencies have made use of AI to increase the efficiency and quality of patent examination. We support the USPTO's efforts in this area and encourage the Office to continue developing its capacity to keep pace with advances in the technology.

Thank you for considering these comments. We welcome further dialogue or opportunity to provide additional information to assist your efforts.

Best regards,



Henry Hadad
President