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Will Artificial Intelligence Change Some Patent Law Paradigms?

"Science, like nothing else among the institutions of mankind, grows like a weed every year. Art is subject to arbitrary fashion, religion is inwardly focused and driven only to sustain itself, law shuttles between freeing us and enslaving us."
K.B. Mullis (Nobel Laureate for Chemistry 1993)

1. Introduction

The growth of scientific and technical literature reporting on developments and achievements in artificial intelligence (AI), in its broadest sense understood as "a collection of technologies that combine data, algorithms and computer power",[1] is impressive. Since the mid of the last century, some 1.6 million AI-related scientific publications have been published, more than half of them since 2001, and some 340.000 AI-related patent applications filed.[2] As statistics reveal, AI technology has already outgrown the stage of theoretical research. The ratio of scientific papers to inventions has decreased from 8:1 in 2010 to 3:1 in 2016.[3] Thanks to enormous investments in and practical applications of AI-related products and processes across all industries, AI technology has become an important technological and economic factor.[4]

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1 European Commission (2020), p. 2.

2 WIPO (2019a), p. 13.

3 Ibid., p. 14 and pp. 39–40.

4 Cf. J. Straus (2021).

2. AI-Technology and its Tools

Closer to the original definition of AI as "the science and engineering of making intelligent machines, especially intelligent programs", "invented" by American computer scientist John McCarthy in 1956,[5] than the broad definition of the EU Commission's White Paper comes that of the Merriam-Webster Dictionary, where AI is defined as "the capability of a machine to imitate intelligent human behavior [and intuition]".[6] Computer scientists found out how to make machines intelligent by developing a method of data analysis that automates analytical model building, which uses algorithms[7] that iteratively learn from data, and which allows computers to find hidden insights without being explicitly programmed where to look, known as machine learning (ML).[8] Moreover, computer scientists have further developed the deep learning method, a form of machine learning that enables computers to learn from experience and understand the world in terms of a hierarchy of concepts. Thus, the computer learns from experience without further interacting with a human operator.[9] To optimise solutions sought, researchers have developed a family of algorithms inspired by biological evolution, such as reproduction, mutation, recombination, crossover and selection, known as evolutionary algorithms (EAs), which form a subset of evolutionary computation techniques (ETs). The most widely known type of ETs is a search technique called genetic algorithm (GA), a category of stochastic search to solving complex problems, which starts with an initial set of random solutions (the population), each representing a solution to the problem at issue (so-called chromosome). After the chromosomes evolved through many successive iterations (called generations), the algorithms converge to the best chromosome, repre-

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5 G. Gurkaynak, I. Yilmaz and G. Haksever (2016), p. 753.

6 Artificial Intelligence, Merriam-Webster.

7 M. Marrafia and A. Paternoster (2017), p. 929, 930, define an algorithm as "an effective procedure to solve a given problem, that is, a finite sequence of elementary and totally explicit (= well defined and not ambiguous) instructions." (Quoted from D. Kim, *'AI-Generated Inventions': Time to Get the Record Straight? GRUR International*, 69 (5), 2020, p. 450). In computational methods, algorithms and codes function together. They "indicate how to organize and describe a series of actions to achieve a desired result: the algorithm constitutes the stage of designing and evaluating the strategy on which to build single actions, while coding reflects the operational phase that leads to the execution of those actions on a particular computing device, such as a PC." (P. Ferragina and F. Luccio, (2018), p. 3, quoted from D. Kim, 2020, p. 450).

8 I. Bratko, (1994), pp. 305–312. However, this does not mean, that ML works without any instructions. ML leverages mathematical and statistical methods. ML process has two components: One is "purely mathematical whereby computational operations are guided by formulas, equations, functions, etc. constituting a part of an algorithm; the other component is a statistical matter whose variables are most correlated with the outcome." (D. Kim, ibid., p. 451 with references to pertinent informatics literature).

9 K.G. Kim (2016), pp. 351–354.

senting the optimum or sub-optimal solution to the problem.[10] However, as Daria Kim observes, also a computer-controlled by a genetic algorithm does not something 'out of the blue' because the application of stochastic randomised local search requires a set of prerequisites that ultimately determine how computation is executed.[11]

The development of an ML algorithm involves: obtaining high-quality data for training the algorithm, accessed or acquired from scientific libraries, etc., pre-processing data, including cleaning data by removing outliers or reducing dimensions, training an ML algorithm on the data, and obtaining a final trained algorithm (i.e. the model), which gives output data (solutions) when shown new input data.[12]

To provide the necessary training for ML algorithms, complex data sets of interest, i.e. the "training data", are necessary. ML methods can use two different approaches to train algorithms. Either the data set used for training algorithms (the input data) is "labelled", meaning that it has both relevant features and the target results that the programmer is interested in, i.e. the correct response. In this, so-called supervised learning, the algorithm learns the relationships between the data and the labels to make predictions on new, previously unseen data. By comparing the prediction errors of the models by inputting the validation set data into each model, the algorithm measures their accuracy.[13] In case the training data for algorithms is unlabelled, the ML algorithm is "unsupervised" and develops a model that extracts common elements of interest from the data set, teaching itself the set of features that makes the targeted subject. "In essence, unsupervised machine learning uses data sets that do not have specific labels fed into the algorithm for the purpose of identifying common trends embedded in that data set".[14]

A key AI tool is the "artificial neural networks" (ANN), an "information processing paradigm that is inspired by the way biological systems, such as the brain, process information",[15] for which patent applications have been filed since the late 1980s, and patents granted since the beginning of 1990s.[16] Shimon Ullman describes ANN as "highly

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10 Cf. '*Evolutionary Algorithm*', Wikipedia, <https://en.wikipedia.org/wiki/Evolutionary_algorithm> (last accessed 17 August 2020). See for more M. Gen and L. Lin (2009), pp. 489–490 with further references and D. Kim, 2020, p. 451 with further references.

11 D. Kim, 2020, p. 452.

12 Cf. H.R. Jin, 2018, p. 89; and A. Greenberg, 2020, pp. 329–337.

13 H.R. JIN, 2018.

14 Ibid.

15 C. Stergiou and D. Siganos, 2014.

16 For instance, on 10 July 1990, the US Patent and Trademark Office (USPTO) granted US Patent 4,941,122 for 'Neural Network Image Processing System'; on 6 October 1992 US Patent 5,153,923 for 'High Order Information Processing Method by Means of a Neural Network and Minimum Searching Method Therefor'; on 23 March 1993 US Patent 5,197,114 for 'Computer Neural Network Regulatory Process Control System and Method', which allowed for the elimination of a human operator from real time control of the process; and, the last to refer to, on 22 December

reductionist approach to model cortical circuitry" and observes that "in its basic current form, known as a "deep network" (or deep net) architecture, this brain-inspired model is built from successive layers of neuron-like elements, connected by adjustable weights[17], called "synapses" after their biological counterparts".[18] ANNs, like humans, learn by example. ANNs have

> "The ability to derive meaning from complicated or imprecise data can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an 'expert' in the category of information it has been given to analyze."[19]

How powerful these ANN machine learning algorithms are, is best demonstrated by the AlphaZero program, using a deep neural network, that recently convincingly defeated the world champion programs in the games of chess and shogi (Japanese chess), as well as Go. The AlphaZero algorithm starts from random play and with no domain knowledge given, except the game rules. Unlike the state-of-the-art programs, which are based on powerful engines that search many millions of positions,[20] leveraging domain expertise and sophisticated domain adaptations, AlphaZero learns the necessary move probabilities and value estimates entirely from self-play and uses them to guide its search in future games.[21]

However, as Greenberg emphasises, although "ML algorithms learn from the data and come up with a final model spontaneously, the developer's ingenuity still plays a major role". She points to the fact that the development process "including choosing which ML method(s) to employ for a given problem, how to curate the training data, which algorithm parameters to select, and how to test the model for accuracy", still requires many human decisions.[22] Thus, "The role of human intervention remains fundamental

1998 US Patent 5,852,815 for 'Neural Network Based Prototyping System and Method', which does not require algorithmic based software in order to train or operate.

17 Weight is the parameter within a neural network that transforms input data within the network's hidden layers, <https://deepai.org/machine-learning-glossary-and-terms/weight-artificial-neural-network> (last accessed 3 August 2020).

18 Sh. Ullman, 2019, pp. 692–693.

19 C. Stergiou and D. Siganos, 2014.

20 In case of the AlphaGo model, defeated by AlphaZero, the model was built by reinforcement learning from a database consisting of over 13 million moves of world class Go players (cf. D. Silver et al., 2016, p. 484; see also H.R. Jin, 2018, p. 80).

21 D. Silver et al., 2019, pp. 1140–1144.

22 A. Greenberg, 2020, pp. 334–335. Along the same lines with detailed arguments D. Kim, 2020, p. 455.

to the programming of AI devices, the selection of input data and the application of the results obtained."[23, 24]

3. Does AI Autonomously Generate Products and Processes?

AI-related reports in scientific magazines, however, suggest seemingly the opposite and entrap many legal scholars to buy into the idea that AI itself, meaning autonomously, generates patentable inventions.[25] The publications of Jo Marchant, "Powerful Antibiotics Discovered Using AI",[26] Robert Service, "AIs Direct Search for Materials Breakthroughs – Decision Making Algorithms Transform How Robots Evaluate and Synthesize Solar Cells and More", [27] and Derek Lowe, "AI Designs Organic Syntheses",[28]may illustrate this.

In the case of the discovered new antibiotic halicin, reported by Marchant, the original research report in the "Cell" Magazine shows that the group around Regina Barzilay and James J. Collins, first trained a deep neural network model to predict growth inhibition of *Escherichia Coli* using a collection of 2.335 molecules. Then they applied the resulting model to several discrete libraries, comprising more than 107 million molecules, to identify potential lead compounds with activity against *E. Coli*. After ranking the compounds according to the model's predicted score, they lastly selected a list of candidates based on a pre-specified prediction score threshold, chemical structure and ability.[29] As described in detail, each of those steps required making complex decisions by the group.[30]

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23 Committee of Legal Affairs of the European Parliament, Report on "Intellectual Property Rights for the Development of Artificial Intelligence" of 2 October 2020, Explanatory Statement, pp. 12–13 (Doc. PE650.527v02-00, A9 - 0176/2020).

24 The reported AI achievements still belong in the so-called category of "Artificial Narrow Intelligence". Although the AI development is approaching its next stage, the so-called "Artificial General Intelligence", meaning that computers will be "as smart as humans in every aspect and capable of performing all intellectual tasks humans can", the point in time when this will become reality, is an open question. Much more so the question, when the serious concern causing so-called "Artificial Superintelligence" will concur the world. Potentially the AI superintelligence will be "much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills." See for more J. Straus, 2021, with further references.

25 A current example is the publication of E. Bonadio, L. McDonagh and P. Dinev, 2021, pp. 48–66.

26 *Nature News,* 20 February 2020, <https://www.nature.com/articles/d41586-020-00018-3> (last accessed 5 August 2020).

27 365 *Science*, 2019, pp. 1295–1296.

28 555 *Nature,* 2018, pp. 592–593.

29 J.M. Stokes et al., 2020, pp. 689–690.

30 Ibid., pp. 690–702. N. Benaich, 2020, p. 21), assessed the decisive role of researchers in this case as follows: "AI only uncovered the new antibiotic with the help of human researchers, who ensured

As regards the article "AIs direct search for materials", the breakthrough for the thin-film materials, which, according to Robert Service, a group of Canadian and US researchers led by C.P. Berlinguette has achieved by outsourcing the effort to a single-armed robot overseen by an AI algorithm, the final outcome of the process cannot be attributed to the employed AI alone. Even though the robot controlled by AI mixed different solutions, cast them in films, performed heat treatments and other processing steps, tested the films' conductivity, evaluated their microstructure, and logged the results, and the AI interpreted each experiment and determined what to synthesise next[31], along this entire process, many decisive decisions of the group had to be taken. As the publication of C.P. Berlinguette and his group[32] reveals, they designed the complex Ada (the robot) self-driving laboratory specifically "to target organic hole and electron transport layers that are ubiquitous in advanced solar cells, as well as optoelectronics applications such as organic lasers and light-emitting diodes". They, among others, selected the material whose hole mobility should be autonomously optimised. They organised the production of surrogate hole mobility data for optical and conductivity properties characterisation and, for instance, selected the Phoenics global Bayesian optimisation algorithm.[33]

Derek Lowe article's title "AI Designs Organic Syntheses" follows the headline "Software that devises effective schemes for synthetic chemistry has depended on the input of rules from researchers. *A system is now reported in which an artificial-intelligence program learns the rules for itself*. See Article p.604"[34]. However, already the abstract of that article of Marvin H.S. Segler, Mike Preuss & Mark P. Waller, *"Planning Chemical Syntheses With Deep Neural Networks and Symbolic AI"* at p. 604,[35] to which Lowe refers, indicates that much more is at stake than just an AI program. The authors begin, "Here we use Monte Carlo tree search and symbolic artificial intelligence (AI) to discover retrosynthetic routes. We combined Monte Carlo tree search with an expansion policy network that guides the search and a filter network to pre-select the most promising retrosynthetic steps. These deep neural networks were trained on essentially all reactions ever published in organic chemistry".[36] What this means specifically, one learns from the article. First, that the authors selected Monte Carlo tree search (MCTS), because it is a general search technique for sequential decision problems with large branching factors without strong heuristics. It uses rollouts to determine position values. Thereby roll-

the computer avoided killing people by helping it distinguish between bad bacteria and species that are beneficial to healthy living cells."

31 R.F. Service, 2019, p. 1295.

32 B.P. Macleod et al.

33 Ibid.

34 555 *Nature*, 2018, 592 (emphasis added).

35 M.H.S. Segler, M. Preuss and M.P. Waller, 2018, p. 604.

36 Ibid.

outs are Monte Carlo simulations, in which random search steps are performed without branching until a solution is found or a maximum depth reached. One learns further that the authors combined three different neural networks with MCTS to perform chemical synthesis planning (3N-MCTS). The first neural network (the expansion policy) guides the search in promising directions by proposing a restricted number of automatically extracted transformations. A second neural network then predicts whether the proposed reactions are actually feasible (in scope). Finally, a third neural network, responsible to estimate the position value, samples transformations during the rollout phase. To train the three neural networks, the group first extracted transformation rules from 12.4 million single-step reactions from the Reaxys36 chemistry database, then determined the extraction rules for selections to train the neural networks. The group, among others, also trained a deep neural network as a binary classifier on successful and failed reactions to predict whether the reactions corresponding to the transformations selected by the policy network are actually feasible. Because researchers seldom report failed reactions, the group itself, based on a process it developed, generated 100 million negative reactions from reactions published before 2015 for training and 10 million published in and after 2015 for testing. The last to mention here, the expansion procedure and the rollout procedure the group incorporated in the respective phases of an MCTS algorithm as a pipeline to form 3N-MCTS. As a result, the four MCTS phases are then iterated to build the search tree.[37] The group has also evaluated the performance of 3N-MCTS by comparing its algorithm to the state-of-the-art search method, the best first search (BFS) with the hand-coded SMILES heuristic cost function.[38]

For all the three reported cases, the above modest 'technical analysis' has revealed that the design of the respective overall procedure, meaning the instructions on the derivation of the input-output relations, were provided by humans. This seems to be in line with the present stage of problem-solving complex computational methods employing AI tools,[39] as assessed by experts in AI and robotics. They "caution that characteristics such as 'autonomous', 'unpredictable' and 'self-learning' are 'based on an *overvaluation* of the actual capabilities of even the most advanced robots, a *superficial* understanding of unpredictability and self-learning capacities [...], a robot perception distorted by Science-Fiction and a few recent sensational press announcements."[40]

37 Ibid., pp. 604–605.

38 Ibid., p. 606.

39 For the phases of computational problem solving, cf. D. Kim, 2020, Table at p. 449.

40 'Open Letter to the European Commission. Artificial Intelligence and Robotics', para. 2 (emphasis added) (quoted from D. Kim, 2020, p. 444). See also *infra* n. 7 (iii).

4. AI-Related Inventions in Patent Granting Practice

4.1. WIPO Statistics

With reference to the WIPO Statistics[41] at the outset, this paper recalled that since the mid of the last century, some 340.000 AI-related patent applications have been filed. As the WIPO statistics referred to specifically reveal, the machine learning technique with 89 percent of patent families, which is included in more than a third of all identified inventions, dominates the field. ML is followed by neural networks, machine learning (general), supervised learning, probabilistic graphical models, support vector machines, bio-inspired approaches, classification and regression trees, deep learning, rule learning, unsupervised learning and another twelve AI technique sub-categories.[42] Thereby IBM, with 8.290 inventions, has the largest portfolio of AI patent applications, followed by Microsoft with 5.930 applications. The other three companies in the top five filers are Toshiba with 5.223, Samsung with 5.102 and NEC with 4.406 applications. Of the top 30 patent applicants by numbers of patent families are twelve from Japan, six from the USA, five from China and four from Europe (Siemens ranking No. 11, Bosch No. 21, Philips No. 24 and Nokia No. 25), and three from Korea.[43] Remarkably, among the top 500 patent applicants are 167 universities and public research organizations. Of these, 110 are Chinese (the top 10 are all from China!),[44] 20 are from the USA, 19 from Korea, 4 from Japan and 4 from Europe (highest ranking the German Fraunhofer Institute, ranking No. 159).[45]

The WIPO Statistics does not reveal any numbers on actually granted patents on AI-related inventions. However, it contains interesting data on litigation and opposition cases. According to these statistics, 1.264 AI patent families were involved in litigation cases and 4.231 in opposition cases from 1975 to 2017.[46] Among the top litigation plaintiffs by several litigated patent families are Nuance Communications, American Vehicular Sciences and Automotive Technologies International.[47] At the top of the list of defendants is Microsoft, prominently followed by Apple, Alphabet, Samsung, Amazon, Sony and BMW.[48] As regards the available data for oppositions in the EPO, the top three opponents are Siemens, Daimler and Giesecke+Devrient from Germany, and the top three defendants are Samsung, LG Corporation and Hyundai, all from Korea.[49] The WIPO

41 WIPO 2019.

42 Ibid., Figure 3.5 at p. 42.

43 WIPO 2019, p. 15.

44 Ibid., Figure 4.1 at p. 60.

45 Ibid., p. 16.

46 Ibid., p. 111.

47 Ibid., Figure 6.5 at p. 110 and text at pp. 112–113.

48 Ibid., Figure 6.6, at p. 114 and text at pp. 113–115.

49 Ibid., Figures 6.8 and 6.9, at pp. 114–116, and text at pp. 115–117.

Statistics suggests that AI-related inventions are treated as patentable subject matter and are granted patents if they fulfil the statutory patentability requirements.

4.2. European Patent Office

Under Article 52 (1) of the European Patent Convention (EPC), European patents shall be granted for any inventions in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application. However, Article 52 EPC in its paragraph 2 sets forth that, *inter alia,* mathematical methods (a), rules and methods for performing mental acts and computer programs (c) are not regarded as inventions and excluded from patentability, provided, as clarified in its paragraph 3, that they are claimed as such.

The *European Patent Office* (EPO) considers AI as an enabling technology of the Fourth industrial revolution.[50] Annual patent applications in the field of AI in the EPO have grown tenfold in the last decade, to more than 800 filings in 2020.[51] The Guidelines for Examination in the European Patent Office[52] clarify that AI and ML "are based on computational models and algorithms for classification, clustering, regression and dimensionality reduction, such as neural networks, genetic algorithms, support vector machines, k-means, kernel regression and discriminant analysis". *Per se*, such models were of an abstract mathematical nature even if they can be 'trained' based on training data. Thus, they, like mathematical methods, are patentable if they contribute to the technical character of an invention. For the assessment of their contribution, it is decisive whether they, in the context of the invention, serve a technical purpose.[53] The EPO Guidelines stress that AI and ML find application in many fields of technology. As examples for the use of algorithms making a technical contribution, they point to the use of a neural network in a heart-monitoring apparatus to identify irregular heartbeats and the classification of digital images, videos, audio or speech signals based on low-level features (e.g. edges or pixel attributes for images). Moreover, the Guidelines explain that, where a classification method serves a technical purpose, "the steps of generating the training set

50 Cf. EPO, *Patents and the Fourth Industrial Revolution: The Global Technology Trends Enabling the Data-Driven Economy,* Munich, December 2020, Table 2.2 at p. 20.

51 EPO Patent Index 2020, p. 4.

52 November 2019 edition.

53 EPO Examination Guidelines Part G-II, 3.6 2020, approvingly point out that "mathematical methods as such are excluded from patentability unless they are used for a technical purpose in the context of technical inventions, […]". The Committee also underlines "the role of the patent protection framework in incentivizing AI inventions and promoting their dissemination, as well as the need to create opportunities for European companies and start-ups to foster the development and uptake of AI in Europe, […]" (ibid., No. 12, p. 8).

and training the classifier may also contribute to the technical character of the invention if they support achieving that technical purpose."[54]

4.3. *Japan Patent Office*

Similar to the handling of AI-related inventions in the practice of the EPO is the practice of the *Japan Patent Office* (JPO). Article 29 (1) of the Japanese Patent Act (JPA) sets forth that any person who has made an invention which is industrially applicable may obtain a patent therefore. Thereby Article 2 (1) JPA defines "'invention' as the highly advanced creation of technical ideas utilizing the laws of nature", and Article 2 (4) JPA states that

> "A 'computer program, etc.' in this Act means a computer program (a set of instructions given to an electronic computer which are combined in order to produce a specific result,...) and any other information that is to be processed by an electronic computer equivalent to a computer program."

The JPO Examination Guidelines clarify that: "Those [inventions] utilizing the laws of nature as a whole and being considered as a 'creation of a technical idea utilizing the laws of nature' constitute a statutory 'invention' without being examined from the perspective of computer software, even though they utilize computer software". This applies to inventions that either concretely perform control of an apparatus (e.g. rice cooker, the washing machine, engine, hard disk drive, chemical reaction apparatus, nucleic acid amplifier), or concern the processing of that control, or concretely perform information based on the technical properties such as physical, chemical, biological or electric properties of an object (e.g. rotation rate of engine, rolling temperature, the relation between gene sequence and expression of a trait in a living body, physical or chemical relation of bound substances).[55] The Guidelines further clarify the notion "equivalent to programs" used in Article 2 (4) JPA, as "not direct instructions to computers and thus cannot be called programs, but have similar properties to programs in terms of prescribing computer processing. For example, 'data structure', a logical structure of data that is expressed by correlations between data elements.[56] The JPO Examination Handbook clarifies that, if "it is clear in consideration of the description, drawings and the common general knowledge at the time of filing, that the claimed invention is a 'program' even though the claimed subject matter is any word other than the 'program' (for example, 'module', 'library', 'neural network', 'support vector machine' or 'model')".[57]

54 Ibid., Part G-II, 3.3.1. For the EPO practice, see also Y. Ménière and H. Pihlajamaa, 2019, pp. 332–336.

55 Part III, Chapter 1 No. 2.2 (1) of JPO Examination Guidelines. Ibid, No. 2.2 (1).

56 Ibid., No. 2.2 (1) (Note).

57 Annex B, Chapter 1, No. 1.2.1.2 Points to Note, <https://www.jpo.go.jp/e/system/laws/rule/guideline/patent/handbook_shinsa/document/index/app_b1_e.pdf> (last accessed 18 August 2020).

The JPO distinguishes between two main categories of AI-related inventions. The first category constitutes *AI core inventions*, characterised by mathematical or statistical information processing technology that forms the basis of AI, such as various machine learning methods including neural networks, deep learning, support vector machines, reinforcement learning, in addition to knowledge-based models and fuzzy logic, etc. The JPO assigns these inventions the International Patent Classification (IPC) code G06N. The second category designated as AI-applied inventions is applying AI core inventions to various technical fields. Such fields are image processing, speech processing, natural language processing, device control/robotics, various diagnoses/detection/prediction/optimization systems, etc.[58] The JPO 'Recent Trends in AI-related Inventions Report' published in July 2020 reveals that the number of domestic applications for AI-related inventions in 2018 reached a total of 4.728 applications, of which 1.527 related to the so-called AI-core inventions.[59] In 2016, the JPO granted 803 AI-related patents and, simultaneously, refused 184 applications for AI-related inventions, meaning that the grant rate was about 80%.[60] The published statistics of JPO also contains interesting information on the application trends in various fields of AI technology.

Statistics published by the JPO Report show that the USA with 5.954 applications and China with 6.858 applications for AI core inventions in 2017 are the major application destinations in the world.[61] These impressive data implicitly indicate that in both countries, the US and China, AI-related inventions are, in principle, eligible for patent protection.

4.4. State Intellectual Property Office of PR China

Article 2.2 of the Patent Law of the *Peoples Republic of China* (CPA) of 1984, in its version in force, defines the term "'invention' as any new technical solution relating to a product, a process or an improvement thereof." Thereby the Examination Guidelines of the State Intellectual Property Office (SIPO)[62] define "'a technical solution' as an aggregation of technical means applying to laws of nature to solve a technical prob-

[58] JPO Patent Examination Department, 2020, Box at p. 3; see also Comments to Patenting Artificial Intelligence Inventions submitted by the Examination Standards Office, Administrative Affairs Division, Japan Patent Office of September 2019 to the United States Patent and Trademark Office (USPTO), *Request for Comments on Patenting Artificial Intelligence Inventions* of 21 August 2019, Federal Register/Vol. 84, No. 166 of 27 August 2019/Notices 44889.

[59] Ibid., Figure 3 at p. 4.

[60] Ibid., Figure 6 at p. 7.

[61] Figure 14 at p. 18, followed by Korea with 1.228, Japan 803 and EPO with 648 applications (ibid).

[62] Ordinance No. 55 of January 2010.

lem".[63] Similar to Article 52 (2) EPC, Article 25.1 and 2 CPA excludes from patentability scientific discoveries and rules and methods for mental activities. Thereby the SIPO Examination Guidelines clarify that a patent shall not be granted if a claim is defined by rules and methods for mental activities in the whole contents. In substance, it concerns only rules and methods for mental activities.[64] Among the many examples for such rules and methods, the Guidelines indicate 'computer programs *per se*'. However, the Guidelines also state that "if a claim in its whole contents contains not only matter of rule or method for mental activities but also technical features, then the claim, viewed as a whole, is not a rule or method for mental activities, and shall not be excluded from patentability under Article 25".[65] Under the title 'Some Provisions on Examination of Invention Applications Relating to Computer Programs', Chapter 9 of Part II of the SIPO Examination Guidelines offers important details related to the patentability of computer programs and the computer implemented inventions. First, 'computer programs *per se*' are defined as meaning "a coded instruction sequence which can be executed by a device capable of information processing, e.g., a computer, so that certain results can be obtained, or a symbolized instruction sequence, or a symbolized statement sequence, which can be transformed automatically into a coded instruction sequence. Computer programs per se include source programs and object programs". Moreover, the Guidelines clarify that the term the invention relating to computer programs refers to solutions for solving the problems of the invention which are wholly or partly based on the process of computer programs and control or process external or internal objects of a computer by the computer executing the programs according to the process mentioned above.[66] A key statement in the Guidelines is the clarification that

> "If the solution of an invention application relating to computer programs involves the execution of computer programs to solve technical problems, and reflects technical means in conformity with the laws of nature by computers running programs to control and process external or internal objects, and thus technical effects in conformity with the laws of nature are obtained, the solution is a technical solution as provided for in Article 2.2 and is the *subject matter* of patent protection."[67]

As such patentable inventions, the Guidelines offer *inter alia* the following examples: 'A method for controlling a die forming process of rubber', 'A method for enlarging storage capacity of mobile computing devices', 'A method of removing image noise', or 'A

[63] Part II, Chapter 1.2, adding that "usually technical means are embodied as technical features". Further that "a solution that does not adopt technical means to solve a technical problem and thereby does not achieve any technical effect in compliance with the laws of nature does not constitute a subject matter" under Article 2.2 CPA (ibid.)

[64] Part II, Chapter 1, Section 4.2 (1).

[65] Ibid., Section 4.2 (2).

[66] Part II, Chapter 9.1.

[67] Ibid., under Section 2 (2).

method of measuring liquid viscosity using computer programs'.[68] A further approximation to the European and Japanese handling of patentability of computer-implemented inventions, i.e. also AI-related inventions, China has reached with the SIPO Ordinance 74 of February 2017, revising the 2010 Examination Guidelines, which entered into force on April 1, 2017.[69] Section 5.2 of Chapter 9 of Part II of the Guidelines sets forth that claims relating to computer programs may be drafted as a process or product claims, *for instance* (not anymore meaning), the apparatus for executing the process. No matter what kind of claim is drafted. "If it is drafted as an apparatus claim, the various component parts and the connections among them shall be specified, *the said component parts may include not only hardware but also programs*".[70] In the past, such claims were not accepted in SIPO practice.[71]

4.5. United States Patent and Trademark Office

The Patent Act of the USA, the other "major application destination in the world" for AI-related inventions, excels by several particularities. Firstly, § 101 of 35 U.S.C. (1952) defines the subject matter eligible for patent protection. It provides:

> "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefore, subject to the conditions and requirements of this title".

The US Supreme Court case law provided, however, three specific exceptions to § 101 broad patent-eligibility principles: "laws of nature, physical phenomena, and abstract ideas".[72] Based on these exceptions, the Supreme Court, at least since the 1930s, has rejected claims related to, e.g. a scientific truth, or the mathematical expression of it,[73] an algorithm itself,[74] or a mathematical formula.[75] Although the patent-eligibility issue in a number of judicial disputes addressing the patentability of computer programs, business methods, etc., had to be resolved, the Supreme Court only in two more recent decisions set rules for the patent eligibility assessment of interest. In 2012, in *Mayo v. Prometheus*, where the patentability of a method for optimizing the therapeutic efficiency of a drug

[68] Ibid., under Section 3 (2), Examples 4-7.

[69] Cf. Amendments to Chapter 9, Part II (c) Amendments to Section 5.2, and the Appendix: Comparison table of Part II, Chapter 9 between the revised Guidelines of 2017 and those of 2010.

[70] Ibid.

[71] Cf. for more St. Yang.

[72] Cf. US Supreme Court in *Diamond v. Chakrabarty,* 447 U.S. 303, 309 (1980), with further references.

[73] Cf. *Mackay Radio & Telegraph Co. v. Radio Corp. of Am.*, 306 U.S. 86, 94 (1939).

[74] Cf. *Benson*, 409 U.S. 63, 71-72 (1972).

[75] Cf. *Parker v. Flook*, 437 U.S. 584, 594 (1978), *Diamond v. Diehr*, 450 U.S. 175, 191 (1981), and *Bilski v. Kappos*, 561 U.S. 593, 611 (2010).

was at issue, the Court observed that abstract ideas, laws of nature, and natural phenomena "are the basic tools of scientific and technological work" and that "monopolizing these tools by granting patent rights may impede innovation rather than promote it."[76] The Court also set forth a framework for distinguishing patents that claim laws of nature, natural phenomena, and abstract ideas from those that claim patent-eligible applications of those concepts. The Court held that in applying the § 101 exception a distinction must be made between patents that claim "'building blocks' of human ingenuity and those that integrate the building blocks into something more, thereby 'transform[ing] them' into a patent-eligible invention".[77]

In 2014, in *Alice v. CLS Bank* in which the Supreme Court had to decide whether patent claims designated to facilitate the exchange of financial obligations between two parties by using a computer system as a third-party intermediary,[78] reconfirmed the principles established in *Mayo,* and distilled from *Mayo*, a two steps patent-eligibility test. Thereunder, first, it is to determine whether the claims at issue relate to one of the patent-ineligible concepts, i.e., laws of nature, natural phenomena, and abstract ideas. If so, the Court asks, "[w]hat else is there in the claims before us"? To answer that question, the Court considers "the elements of each claim both individually and 'as an ordered combination' to determine whether the additional elements 'transform the nature of the claim' into a patent-eligible application".[79] Step two constitutes "a search for an 'inventive concept'—i.e., an element or combination of elements that is 'sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the [ineligible concept] itself'".[80] Based on the two steps test, the Court rejected the argument of Alice Corp. that its patent claimed a computer-implemented financial settlement system and did not fall into the patent-ineligible category of "abstract ideas". The Court held that the claims were patent-ineligible on the basis that generic computer implementation does not transform a patent-ineligible abstract idea into a patent-eligible invention. Thus, the Supreme Court effectively broadened the scope of ineligible subject matter.

As observed by the Office of the Chief Economist of the USPTO, the *Alice* decision, because the ambiguity in the language of its test standard and the scope of technologies involving 'abstract ideas' made it difficult to predict how and where the standard would be applied.[81] The *Alice* decision created uncertainty in the businesses and legal communities, and after its implementation in the USPTO practice, also led to a significant

76 *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66, 71 (2012).

77 566 U.S. 89 (2012).

78 *Alice Corp. Pty. Ltd. v. CLS Bank Int'l.*, 573 U.S. 208 (2014).

79 573 U.S. 217 (2014), quoting *Mayo.*

80 Ibid., quoting *Mayo.*

81 Cf. *Adjusting to Alice – USPTO Patent Examination Outcomes after Alice Corp. v. CLS Bank International*, Office of the Chief Economist IP Data Highlights, No. 3, April 2020, p. 2.

increase in the percentage of first office action § 101 rejections for patent applications in the so-called *Alice*-affected technologies.[82]

In its efforts to bring more clarity in the application of the *Alice/Mayo* two-part test, the only test to use to evaluate the eligibility claims, the USPTO, in 2019, revised the 2106 Patent Subject Matter Eligibility Guidance (PEG) in its Manual of Patent Examining Procedure (MPEP).[83] With reference to the case law, the MPEP declares the *Alice/Mayo* test as the only applicable test. The 'machine-or-transformation-test', i.e. a test defining a 'process' patent-eligible only if: (1) it is tied to a particular machine or apparatus, or (2) it transforms a particular article into a different state or thing,[84] although an important clue to eligibility, was not a separate test. Instead, that test should be considered "as a part of the 'integration' determination or 'significantly more' determination articulated in the *Alice/Mayo* test".[85] An MPEP Flow Chart on the 'Subject Matter Eligibility Test for Products and Processes' provides valuable guidance for examiners as well as applicants.

In a Notice of 1 July 2019,[86] the USPTO also explained that under the Revised Guidance, abstract ideas can be grouped as, e.g., mathematical concepts, certain methods of organizing human activity, and mental processes. Further, that a patent claim or patent application claim that recites a judicial exception is not 'directed to' the judicial exception if the judicial exception is integrated into a practical application. Lastly, that a claim that recites a judicial exception, but is not integrated into a practical application, is directed to the judicial exception and must, therefore, in a further step, be evaluated as regards the 'inventive concept' to determine the subject matter eligibility of the claim.

For a better understanding and more efficient handling of the *Alice/Mayo* test by examiners and applicants, the USPTO, in 2019, published more than 40 hypothetical examples intended to illustrate the claim analysis under the 2019 PEG.[87] Among them are the following two: The first concerns a "Method for Training a Neural Network for Facial Detection", claiming:

> "A computer-implemented method of training a neural network for facial detection
>
> comprising:
>
> collecting a set of digital facial images from a database;

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82 Ibid., p. 4 and Figure 2.

83 <https://www.uspto.gov/web/offices/pac/mpep/index.html> (last accessed 31 August 2020).

84 Cf. *Bilski v. Kappos*, 561 U.S. 605 (2010).

85 2106 MPEP [R-10.2019].

86 2019 Revised Patent Subject Matter Eligibility Guidance (PEG), <https://www.federalregister.gov/documents/2019/01/07/2018-28282/2019-revised-patent-subject-matter-eligibility-guidance> (last accessed 31 August 2020).

87 <https://www.uspto.gov/sites/default/files/documents/101_examples_1to36.pdf> (last accessed 2 September 2020) and <https://www.uspto.gov/sites/default/files/documents/101_examples_37to42_20190107.pdf> (last accessed 2 September 2020).

applying one or more transformations to each digital facial image including mirroring, rotating, smoothing, or contrast reduction to create a modified set of digital facial images;

creating a first training set comprising the collected set of digital facial images, the modified set of digital facial images, and a set of digital non-facial images;

training the neural network in a first stage using the first training set;

creating a second training set for the second stage of training comprising the first training set and digital non-facial images that are incorrectly detected as facial images after the first stage of training; and

training the neural network in a second stage using the second training set."

According to the analysis offered, the claim recites a series of steps and, therefore, is a process, i.e. falls in a statutory category. The claim is patent-eligible, because it does not recite any of the judicial exceptions in the 2019 PEG. Neither mathematical relationships nor concepts, formulas or calculations, nor mental processes – the steps are not practically performed in the human mind – are recited in the claim. Finally, the claim does not recite any method of organizing human activity such as a fundamental economic concept or managing interactions between people. There is no need to examine where the claimed method is integrated into a Practical Application, or provides an inventive concept, i.e. the question to be answered in the second part of the *Alice/Mayo* test if the claim recites a judicial exception.[88]

The second example relates to "Cryptographic Communications" and claims

"A method for establishing cryptographic communications between a first computer terminal and a second computer terminal comprising:

receiving a plaintext word signal at the first computer terminal;

transforming the plaintext word signal to one or more message block word signals M_A;

encoding each of the message block word signals M_A to produce a ciphertext word signal C_A, whereby $C_A=M_A^e$ (mod n);

where C_A is a number representative of an encoded form of message word M_A;

where M_A corresponds to a number representative of a message and $0 \leq M_A \leq n-1$;

where n is a composite number of the form n=p*q;

where p and q are prime numbers;

where e is a number relatively prime to (p-1)*(q-1); and

88 Example 39, pp. 8–9, <https://www.uspto.gov/sites/default/files/documents/101_examples_37to42_20190107.pdf> (last accessed 2 September 2020).

transmitting the cypher text word signal C_A to the second computer terminal over a communication channel."

The USPTO analysis reveals that the claim falls in a statutory category because it recites a series of steps and, therefore, is a patent process. However, because the claim recites a mathematical formula or calculation that is used to encode each of the message block word signals M_A to produce a cypher text word signal C_A, whereby $C_A=M_A^e$ (mod n), the claim recites a judicial exception. Consequently, questions from Part 2 of the *Alice/Mayo* test are at issue. To start with, is the judicial exception, recited in the claim, integrated into a Practical Application? The USPTO analysis answers this question in the affirmative. This is because the combination of additional elements in the claim (receiving the plaintext word signal at the first computer terminal, transforming the plaintext word signal to one or more message block word signals MA, and transmitting the encoded cypher text word signal CA to the second computer terminal over a communication channel) integrates the exception into a practical application. The analysis emphasises that the combination of additional elements uses the mathematical formulas and calculations in a specific manner that sufficiently limits the use of the mathematical concepts to the practical application of transmitting the cypher text word signal to a computer terminal over a communication channel. Therefore, the mathematical concepts are integrated into a process that secures private network communications. They allow a cypher text word signal to be transmitted between computers of people who do not know each other or who have not shared a private key between them in advance of the message being transmitted, where the security of the cypher relies on the difficulty of factoring large integers by computers. As a result, the claim is not directed to the recited judicial exception and is eligible. The analysis further notes that well-understood, routine, conventional subject matter can integrate an abstract idea into a practical application. Thus, even though receiving a signal at a first computer, transforming it and transmitting the transformed signal to a second computer described in the background as being conventional, the *Alice/Mayo* Part 2 step does not evaluate whether the additional elements are conventional to determine whether the abstract idea is integrated into a practical application. Because the judicial exception recited in the claim is integrated into a practical application, there is no need to examine whether the claim provides an Inventive Concept. Thus, the claim is patent-eligible.[89]

Statistics show that the new USPTO Examiner Guidance significantly decreased uncertainty in patent examination and markedly reduced the first office § 101 rejections of patent applications in *Alice/Mayo*-affected technologies.[90] Although the US legal technique for assessing the patent eligibility of computer-implemented inventions, to

[89] Example 41, pp. 14–16, <https://www.uspto.gov/sites/default/files/documents/101_examples_37to42_20190107.pdf> (last accessed 2 September 2020).

[90] Cf. *Adjusting to Alice*, Figure 4 at pp. 6.

which also AI-related inventions belong, differs from that applied in the EPO, JPO and SIPO, the result of the assessment may still be quite similar. The 2019 USPTO Examiner Guidance has apparently reduced the existing uncertainty and increased the probability that the validity of the many patents granted by the USPTO in this area will stand scrutiny in US courts.[91]

5. AI Inventions and Patent Law Paradigms

5.1. Patent Law Paradigms

Irrespective the differences which exist in patent laws of various jurisdictions, the rule that the patent right shall belong to the inventor,[92] the subject matter patent eligibility standard,[93] the rules controlling the requirements which a "statutory invention" must fulfil to be patentable,[94] and the sufficient/enabling disclosure standard,[95] can be considered as 'patent law paradigms'. Every advent of a major technological change has since ever challenged the patent law rules controlling its paradigms. To safeguard the proper functioning of the patent system as an instrument of economic policy providing incentives for and rewarding a broad range of useful human activities,[96] legislators and/or courts have further developed and adjusted those rules to the needs generated by the new technology. However, without substantially altering the underlying paradigms. The advent of software in the 1960s and modern biotechnology in the 1970/1980s are the most recent examples. They resulted in adjusted subject matter patent eligibility standards, new provisions providing for the exclusion of specific categories of inventions based on policy or ethical considerations and the instrument of the deposit of biological material in a recognised depository institution as a complement of the disclosure in the written description.[97] The fact that AI technology enables machines, which use algorithms, to learn iteratively from data and experience and think in concepts and eventually turns them into a source of new knowledge (invention?), raises several patent law relevant questions. For instance, whether the machine can be an inventor in patent law terms, whether a technical solution generated by the smart machine autonomously meets the

91 B. Higgins, 2019, pp. 3–8, based on his analysis of the case law of the lower US courts asked for a clarifying of the existing decisions issued by the USPTO (at p. 7), which is now available and should also serve as guidance for the US.

92 Cf., e.g. Article 60 (1) EPC; §§ 101, 116, 35 U.S.C.

93 Cf., e.g. Article 52 EPC; § 101, 35 U.S.C.

94 Cf., e.g. Articles 54-57 EPC; §§ 102 and 103, 35 U.S.C.

95 Cf., e.g. Article 83 EPC; § 112, 35 U.S.C.

96 J. Straus, in: T. Takenaka (ed.), 2013, p. 19.

97 Cf. J. Straus, 2019, pp. 546–554.

subject matter patent eligibility standard, what is the yardstick for assessing inventive step, what constitutes the relevant prior art in such circumstances?

5.2. AI Inventions and Patent Law Paradigms—Debated by Patent Law Scholars

These questions have attracted much attention, especially among US patent law scholars. They inspired some of them not only to question the suitability of the paradigms settled in the US patent law to be applied to AI inventions but even to challenge the applicability of the patent system to this type of invention in general. Although the analyses and the solutions proposed in the reviewed publications[98] markedly differ, they have many characteristics in common. They are predominantly US-law-centric; they take it for granted that AI has already since long autonomously generated inventions, which they call 'AI inventions', they do not attempt to either specifically, i.e. with technical features, define an AI invention, or delimit it from AI-related inventions, understood as a subcategory of computer-implemented inventions. Moreover, they all contest the suitability of current patent law standards for assessing the inventive step (non-obviousness) and determining the relevant prior art of AI inventions and are all discussing the topic in a broad context at a fairly abstract level using a narrow patent law relevant technical basis.

Prior to turning in some detail to the 2016 article of Professor Ryan Abbott,[99] a short reference to the article published by Ravid and Liu and that published by Schuster[100] is made because they represent the most radical turn away from settled patent law paradigms.

As revealed from the following quote, Ravid and Liu place legal issues concerning AI inventions outside the patent law realm:

> "We analyze AI systems as autonomous, creative, unpredictable, rational, and evolving systems, and argue that these characteristics make justifications such as personality theories and incentive/efficiency arguments irrelevant. We conclude that one cannot conclusively determine an owner for these rights within the scope of patent law. Therefore, the rights fall outside the scope of traditional patent law."[101]

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98 Cf., e.g., R. Abbott, 2016, pp. 1079–1126; R. Abbott, 2019, pp. 2–52; W.M. Schuster, 2018, pp. 1945–2004; Sh.Y. Ravid and X. (J.) Liu, 2018, pp. 2215–2262; R.D. Clifford, 2018, pp. 25–39. For more publications of interest see D. Kim, 2020, p. 443; N.Li-T. Koay, 2020, pp. 399–404; T.W. Dornis, 2020, pp. 436–446.

99 R. Abbott, 2016.

100 Both referred to in n. 98 *supra.*

101 Sh. Y. Ravid and X. (J.) Liu, 2018, p. 2221. However, they implicitly agree with granting patents for computer-implemented inventions using AI (ibid).

They propose to abolish patent protection for inventions generated by AI altogether and suggest promoting innovations and public disclosure of AI inventions through alternative tools, such as, for example, first-mover advantages, social recognition of AIs, and the use of digital tools against copying and counterfeiting.[102] Ravid and Liu argue that the new AI realm consists of multiple stakeholders, such as the software programmers, data suppliers, trainers/feedback suppliers, owners of the AI system, operators of the system, new employers of other players, the government, the investor and even the AI system as an autonomous entity,[103] whose interests are at stake. They call their solution a 'Non-patent model within the AI multiplayer paradigm'.[104]

Schuster starts his paper by raising the question of whether and to whom grant patents for AI inventions.[105] After analysing the US case law on the legal threshold for inventorship and a review of US literature addressing AI and IP law,[106] Schuster turns to an extensive analysis of the Coase Theorem in general and a detailed 'Coasean Analysis of Patent Ownership'.[107] Therein Schuster addresses issues such as 'Types of Patent Value', 'Patent Valuation as a Function of Market Participation', 'Assignment of Patent Rights', and the problematic allocation of patent rights to software companies. Although Schuster concedes that further research was needed to answer his initial question, he concludes that "Via a Coasean analysis, the rights to AI patents should be allocated to AI users (i.e., parties using AI to create new technologies) to maximize economic efficiency."[108] Not easy, to say the least, to comprehend this suggestion and place it in the framework of the patent system. Schuster does not explain how it could work in practical terms.

Ryan Abbott, using a more traditional approach, opened his 2016 article,[109] *inter alia*, with the following statements:

> "An innovation revolution is on the horizon. Artificial intelligence has been generating inventive output for decades, and now the continued and exponential growth in computing power is poised to take creative machines from novelties to major drivers of economic growth. A creative singularity in which computers overtake human inventors as the primary source of new discoveries is foreseeable".[110]

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[102] Ibid., pp. 2222, 2252–2257.

[103] Ibid., pp. 2231–2235.

[104] Ibid., p. 2252.

[105] W. M. Schuster, 2018, p. 1948. As revealed later in his paper, Schuster takes it for granted that AI autonomously generates inventions: "Genetic algorithms independently develop new inventions by mimicking biological evolution via 'an iterative process of simulated competition and improvement'." (pp. 1955–1956).

[106] Ibid., pp. 1959–1967.

[107] Ibid., pp. 1967–2000.

[108] Ibid., p. 2004.

[109] Abbott, 2016.

[110] Ibid., pp. 1079–1080.

> "Computers already are generating patentable subject matter under circumstances in which the computer, rather than a human inventor, meets the requirements to qualify as an inventor (a phenomenon that this Article refers to as 'computational invention')".[111]
>
> "Soon computers will be routinely inventing, and it may only be a matter of time until computers are responsible for most innovation".[112]
>
> "It [the article] finds that machines have been autonomously generating patentable results for at least twenty years and that the pace of such invention is likely increasing".[113]

The empirical basis for such bold statements seems narrow, and its interpretation is far from being clear in patent law terms. Abbott's first example is two patents granted by the USPTO to Stephen L. Thaler. The first for a "Device for the Autonomous Generation of Useful Information"[114] which Thaler called 'Creativity Machine' and widely publicised, and the second for a "Neural Network Based Prototyping System and Method"[115] which reportedly was invented by the first patented invention, i.e. the 'Creativity Machine'. Nevertheless, Thaler listed himself as an inventor, assuming that otherwise, he could not get the patent granted. Abbott observes that

> "If Dr. Thaler's claims are accurate, then the Patent Office has already granted, without knowing it has done so, a patent for an invention created by a non-human inventor - and as early as 1998."[116]

The second Abbott's example, titled 'The Invention Machine',[117] relies on publications of John R. Koza.[118] Koza and his team reported, on the one hand, that genetic programming they had developed succeeded in independently generating results that were subject of past patents. And on the other hand, that they got several patents issued by the USPTO, e.g. for 'Methods and Apparatus for Automatic Design of Complex Structures Using Genetic Programming',[119] 'Genetic Programming Problem Solver With Automatically Defined Stores, Loops and Recursions',[120] 'Apparatus for Improved

111 Ibid., p. 1080.

112 Ibid.

113 Ibid., p. 1081.

114 US Patent 5,659.666 (granted/filed on 13 October 1994).

115 US Patent 5,852.815 (granted on 22 December 1998, see also *supra* note 19).

116 Cf. R. Abbott, 2016, pp. 1083–1086 with numerous references.

117 Ibid., pp. 1086–1088.

118 J.R. Koza, 2010, pp. 251–284, at, e.g. 265.

119 US Patent 6,360,191 B1 (granted on 19 March 2002).

120 US Patent 6,532,453 B1 (granted on 11 March 2003).

General Purpose PID and Non-PID Controller',[121] or 'Method and Apparatus for Synthesis of Controllers'.[122] In other words, for inventions generated autonomously by AI. As a third example, Abbott mentions IBM's AI 'Watson', whose '*Jeopardy!*' discoveries in food series were likely patentable.[123]

After a lengthy discussion about whether computers should qualify as 'legal inventors', Abbott answers this question in the affirmative.[124] He argues that this would encourage innovation under an inventive theory.

> "Patents on computational inventions would have substantial value independent of the value of creative computers; allowing computers to be listed as inventors would reward human creative activity up-stream from the computer's inventive act."[125]

Abbot praises 25 January 2005, the day of the US Patent 6,847,851 B1 issue, as of historical significance, because with the patent issue, the genetic programming has passed the 'Turing test', i.e., the examiner did not realise "that he was looking at the intellectual property of a computer".[126] As regards the ownership rights to computational inventions, according to Abbott, they should belong to a computer's owner, who could assign them to users or developers.[127]

Among the most important rules controlling the requirements which a 'statutory invention' must fulfil to be patentable is that the invention involves an inventive step, i.e., that "having regard to state of the art, it is not obvious to a person skilled in the art".[128] Thus, the decisive yardstick for assessing non-obviousness is the person skilled in the art, a fictitious (hypothetical) figure having the knowledge and expertise in the pertinent art at the filing/priority date, to be determined in each individual case according to the field of technology. Whereas it still can be questioned whether AI already autonomously generates patentable inventions,[129] no doubt exists that AI as a tool in many respects and to an ever-increasing extent facilitates researchers/inventors in their innovative activities. Considering the available enormous computer power as regards the speed, storage of

121 US Patent 6,847,851 B1 (granted on 25 January 2005). Abbott reports that John Koza in a telephone interview he had with him told him, that he did listed him and others as inventors in this patent, based on the advice of the legal counsel, although "the whole invention was created by a computer." (ibid., p. 1088 and footnote 68).

122 US Patent 7,117,186 B2 (granted on 3 October 2006).

123 Abbott, 2016, pp. 1088–1091, also mentioning Watson's involvement in drug discovery (cf. also R. Abbott, 2019, pp. 22–23).

124 Ibid., pp. 1092–1113.

125 Ibid., p. 1104.

126 Ibid., p. 1109.

127 Ibid., pp. 1114–1117.

128 Cf., e.g. Article 56 EPC, 35 U.S.C. § 103.

129 See *supra* n. 47 and the accompanying text *infra* 6. (iii).

data, etc., which AI algorithms use, this cannot remain without consequences for the standards controlling the assessment of the inventive step/non-obviousness requirement. Affected by the new circumstances are both the standard for determining the fictitious person skilled in the art and the relevant, pertinent art itself. As regards the skilled person, the widespread use of AI (ML, ANN, EA, ETs and GAs)[130] implies that also this fictitious figure, when confronted with technical solutions involving AI, will also consider for his assessment AI tools, available at the priority date for solving the type of problems at issue. Moreover, the pertinent, relevant prior art will be affected because it will also encompass the data used by the AI assisting the skilled person. As Ralph Clifford observes: "By becoming commonplace, AI has the power to render inventions predictable and obvious".[131] This is because a skilled person—the reference for the non-obvious assessment—assisted by AI will, in any case, dispose of much more background knowledge even in unrelated prior art than has traditionally been the case.

Ryan Abbott considers going even a step further. He suggests not only that the person skilled in the art should be using an inventive machine for the non-obviousness assessment, instead could even be itself "just an inventive machine".[132] Abbott argues, "Having inventive machines replace the skilled person may better correspond with real world conditions".[133] The implications, which the replacement of the skilled person by inventive machines would have, Abbott explains as follows:

> "Thus, inventive machines change the skilled paradigm because once they become the average worker, the average worker becomes inventive. As the outputs of these inventive machines become routinized, however, they should no longer be inventive by definition. The widespread use of these machines should raise the bar for obviousness, so that these machines no longer qualify as inventive but shift to become skilled machines – machines, which now represent the average worker and are no longer capable of routine invention.
>
> […]

[130] Cf. *supra* under section 2.

[131] R. Clifford, 2018, p. 36.

[132] R. Abbott, 2019, p. 2.

[133] Ibid., p. 33. This opinion is shared by D. Fabris, 2020, 685–708, who states: "[...], I believe the PHOSITA/PSITA should be soon replaced by what I call here a "machine of ordinary skill in the art" (MOSITA), which knows, through all the data it incorporates and by means of its computational capacity, all the existing prior art and all possible correlations, even in unrelated scientific fields. In such a scenario, since the AI undertakes R&D activities in a fully autonomous way, the level of skill of the human beings employing them becomes irrelevant." (at p. 692).

> Taken to its logical extreme, and given there is no limit to how sophisticated computers can become, it may be that everything will one day be obvious to commonly used computers."[134]

However, Abbott eventually realises that instead of replacing the skilled person with the skilled machine, it would be "less of a conceptual change, and administratively easier, to characterize the skilled person as an average worker facilitated by technology".[135] That way would more explicitly take into account the fact that human researchers' capabilities are augmented with computers. Here Abbott concedes that also in inventions using AI significant skills may be required to formulate the precise problem to put to a machine so that a person might have a claim to inventorship independent of the machine, or a claim to joint inventorship.[136] As a firm believer in inventive machines, Abbott closes his extensive deliberations on non-obviousness with the following sentence: "Inventive machines may ultimately automate knowledge work and render human researchers redundant".[137]

6. Stephen L. Thaler's—DABUS Patent Applications

6.1. Machine—A 'Statutory Inventor'?

Inspired possibly by Ryan Abbott's writings, Stephen L. Thaler, who according to the narrative suppressed to list in the US patent applications his "creative machine" as an inventor,[138] filed on 17 October and 7 November 2018 with the USPTO, EPO and the UK Intellectual Property Office (UK IPO) two patent applications without listing the inventor.[139] Invited by the EPO and UK IPO to remedy the deficiency and designate the inventor as set forth in Article 81 and Rule 19 (1) EPC, and Section 13 of the UK 1977Patents Act, Thaler indicated as an inventor a machine, DABUS (stands for Device for Autonomous Bootstrapping of Unified Sentience). Thaler, as an applicant, explained that DABUS is a type of connectionist artificial intelligence (AI) from which he had acquired the right to the European patent as an employer, i.e. as a successor in title. Thaler declared that the invention had been made by a machine and that the machine "identified the novelty of its own idea before a natural person did". Moreover, he argued that

134 Ibid., p. 34. D. Fabris, 2020, pp. 698 ff, considers an intensified use of the so-called 'secondary considerations', in particular, the solution to 'long-felt but unsolved needs', as a possible remedy for overcoming the nonobviousness bar.

135 Ibid., p. 35.

136 Ibid., p. 36.

137 Ibid., p. 51.

138 See *supra* section5.2, n. 125 and the accompanying text.

139 EP 3 564 144 A1, filed on 17 October 2018 (Application No. 18275163.6), GB 181909.4 for "Food Container", and EP 3 563 896 A1, filed on 7 November 2018 (Application No. 18275174.3), GB 1818161.0 for "Devices and Methods for Attracting Enhanced Attention".

the machine should be recognised as the inventor, and he, as the owner of the machine, was an assignee of any intellectual property rights created by this machine. In line with the ideas published by Abbott, Thaler also reasoned that this was in compliance with the purpose of the patent system, incentivising disclosure of information, commercialisation and development of inventions.[140]

In the oral hearing before the EPO Receiving Section, Thaler further argued that not accepting AI Systems as inventors would exclude inventions made by AI from patentability and would contradict Articles 52–57 EPC. On 27 January 2020, the EPO Receiving Section rejected Thaler's applications and reasoned that indicating the name of a machine (DABUS) does not meet the requirements of Rule 19 (1) EPC. According to the EPO, names given to things may not be equated with names of natural persons. The latter has not only the function of identifying the person but enable it to exercise the rights and forms part of their personality. Things have no right, which a name would allow them to exercise.[141] Contrary to the arguments brought forward by Thaler, the EPO found no support for Thaler's arguments in the EPC travaux preparatoire.[142] The EPO emphasised that the EPC vested with the inventor several rights *vis-à-vis* the applicant for or proprietor of a European patent (Articles 60 (1), 62 and 81, Rules 19 (3), 20 (2) EPC). However, AI Systems or machines have at present no rights because they lack legal personality comparable to natural or legal persons.[143] The EPO's decision noted that the EPO Boards of appeal have recognised that the inventor is a natural person. The fact that the Boards have not yet had an opportunity to decide whether an entity other than a natural person could be regarded inventor does not allow the conclusion that this was the case. In support of its decision, the EPO finally remarked that the understanding that the inventor is a natural person was shared by national courts of various countries, were the standard reported by the majority of the EPC Contracting States, and also followed by the patent offices of China, Japan, Korea and the USA.[144]

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140 Facts summarised in the decision of the EPO of 27 January 2020, rejecting the application No. 18275174.3 (under No. I, 1-5) (EPO Doc. PK23498), <https://www.epo.org/news-events/news/2020/20200128.html> or <https://data.epo.org/publication-server/pdf-document?pn=3563896&ki=A1&cc=EP&pd=20191106> (last accessed 17 August 2020).

141 Ibid., Nos. 23 and 24, with references to pertinent provisions of national civil codes.

142 Ibid., No. 25.

143 Ibid., Nos. 26 and 27.

144 Ibid., Nos. 29 and 30 with further references. Thaler's US DABUS applications were rejected in the USPTO in February 2020, because according to the USPTO the term 'inventor' in 35 U.S.C. § 100 (f) means the "individual or […] individuals who invented or discovered the subject matter of the invention". The USPTO also pointed to the case law of the Court of Appeals for the Federal Circuit indicating that "the patent laws require that an inventor be a natural person" (cf. I. Ireland and J. Lohr, 2020, p. 24).

Already on 4 December 2019, the Comptroller of the UK IPO rejected the two Thaler's applications and reasoned that the naming of the machine as inventor did not meet the requirements of the Patents Act 1977 because a person—meaning a *natural* and not merely a *legal* person—must be identified as the inventor.[145] Thaler appealed the Comptroller's decision before the England and Wales High Court (Patents Court) and brought forward, by and large, the same arguments as before the EPO's Receiving Section. Thaler, in particular, emphasised that patent law also protects the moral rights of human inventors and that acknowledging machines as inventors would facilitate this function. It was fundamentally wrong and weakened the moral justification of patents that, at present, individuals are claiming inventorship of autonomous machine inventions under circumstances in which they have not functioned as inventors. By contrast, acknowledging machines as inventors would also acknowledge the work of the machine's creators.[146] The Court, Justice M. Smith, rejected all of Thaler's arguments and *inter alia* based its decision on the holdings of Lord Hoffmann in *Yeda Research & Development Company Ltd. v. Rhone-Poulenc Rorer International Holdings* ([2007] UK HL 43), who referred to the inventor as the *natural person who came up with the inventive concept*.[147] In view of the controversially debated issue of who is to be acknowledged as inventor in AI related/generated inventions, it seems appropriate to quote the final remarks of Justice Smith, who stated the following:

> "As I have noted, the question of whether the owner/controller of an artificially intelligent machine that 'invents' something can be said, him- or herself, to be the inventor was not a matter that was argued before me. Dr Thaler expressly declined to advance that submission not merely because he considered it bad in law but more importantly because (in moral terms) he considered that he would illegitimately be taking credit for an invention that was not his. Clearly, what arguments are or are not framed in relation to patent applications are matters for the applicant. However, I would wish to clarify that I in no way regard the argument that the owner/controller of an artificially intelligent machine is the 'actual deviser of the invention' as an improper one. Whether the argument succeeds or not is a different question and not one for this appeal: but it would be wrong to regard this judgment as discouraging an applicant from at least advancing the contention if so advised."[148]

[145] Facts reproduced in the decision of the England and Wales High Court (Patents Court) of 21 September 2020 – *Stephen L Thaler v. the Comptroller-General of Patents, Designs and Trade Marks* ([2020] EWHC 2412 (Pat)), para. 7.

[146] Ibid., para. 5.

[147] Ibid., para. 45 (3).

[148] Ibid., para. 52 (2).

6.2. The Claimed Food Container—DABUS Autonomous Invention?

For two reasons, some important patent law aspects of Thaler's, e.g. EP 3 564 144 A1 (EP '144) application remained unaddressed. On the one hand, the EPO, UK IPO and the USPTO proceedings focused exclusively on the question, whether a machine could enjoy the legal status of an inventor. On the other hand, no reason seemingly existed to question the compliance of the EP '144 description with the Rule 42 (b) EPC. This is because, as a matter of principle, a patent grant does neither require the inventor to disclose why the invention works nor that he/she specifically describes the repeated working of the invention if in view of state of the art this is beyond question. Only the facts, which Thaler has disclosed in the UK proceedings, offer the necessary basis for a substantive examination of those aspects. In other words, to examine whether DABUS autonomously, i.e. without human intervention, designed/invented the claimed food container, whether the invention, autonomously designed by DABUS or not, met the inventive step requirement, how the person skilled in the art to assess this should be determined, and what should be considered the relevant prior art.

Thaler neither disclosed how the problem the "machine" was supposed to solve was formulated and by whom, nor how it was introduced into the AI system. He also did not disclose what constituted the "general knowledge in the field" (which field, by whom provided, from where accessed?) for the training of the algorithm (which algorithm, one off the shelf commonly used—by whom selected, or a newly developed, if so, by whom?), which as Thaler claims, were not "any special data relevant to the present invention." Whereas the disclosure of this information was (or at least seemed) irrelevant in the context of the application at hand, it is indeed relevant to the question of whether, where and to what extent human intervention was involved in the problem-solution process chain, which generated the claimed food container. The facts offered by Thaler do not seem to support his claim that DABUS autonomously invented the claimed invention.

6.3. US 'Creative Machine' Patent—Relevant Prior Art?

Thaler's explicit reference to, among others, the US "Creative Machine" patent 5,659,666 (US '666),[149] as the model of the DABUS "Machine", the claimed inventor of the food container, raises several interesting and important issues so far not addressed in the "DABUS" proceedings. Independent of whether DABUS autonomously or not "invented" the food container, the US '666, as a potentially relevant prior art for the DABUS application, requires a closer investigation.

The US '666 relates to a "Device for the Autonomous Generation of Useful Information". To the understanding of this writer, the invention claimed and disclosed in US '666 falls primarily in the category of "AI core inventions" but also discloses

[149] See *supra* n. 114 and the accompanying text.

practical applications of the teaching in some selected fields. Therefore, it represents a "hybrid-type" of an AI invention. Its principal object is "to teach the construction and operation of novel means for simulating creativity.[150] Its task is, as the US'666 Abstract reveals,

> "simulating human creativity employing a neural network trained to produce input-output maps within some predetermined knowledge domain, an apparatus for subjecting the neural network to perturbations that produce changes in the predetermined knowledge domain, the neural network having an optional output for feeding the outputs of the neural network to a second neural network that evaluates and selects outputs based on training within the second neural network."

The description states,

> "The present device represents a new approach and a new application of ANN's in which the system synthesizes novel plans of action and original designs or creations. These systems, which we refer to as autonomous systems or 'creativity machines' may perform imaginative feats that extend beyond technological invention into the realms of aesthetics and emotions."[151]

To show the difference between the claimed invention and the prior art, the description emphasises:

> "The inventor has shown that static networks have produced some very novel outputs which have been detected within mathematical studies. In all known cases, however, they have been isolated by a human operator for their novelty. In contrast, the present device autonomously monitors the output of such a network and selects emergent concepts on the basis of some predetermined criteria established within the policing or patrolling neural network. Such concepts may include producing music or musical themes for some purpose, or *for designing some device such as a coffee mug*, or producing a process planning operation, or solving a problem, and for many other applications some of which will be described more in detail hereinafter."[152]

The description and the drawings disclose in detail the entire structure and operation of the ANN's involved. It also offers a detailed description of some embodiments, among them, that of a *coffee mug* design. In this latter respect, the description, *inter alia*, states:

> "Referring now to FIGs. 5-8[153] there is shown an embodiment of the subject device that can be used in the design and production of devices such as a novel coffee mug

[150] US '666, column 2, lines 62–64.

[151] Ibid., column 1, lines 24–30.

[152] Ibid., column 2, lines 5–18 (emphasis added J.S.).

[153] FIG. 5 is a diagram of one embodiment of the object device used in designing and/or producing a desired shape for a coffee mug, FIG. 6 is a block diagram of the means employed to produce the coffee mug of FIG. 5; FIG. 7 is a view showing one form of the operating members controlled by the subject device in the production of the desired shape for a coffee mug; FIG. 8 shows examples

> and the like. The subject coffee mug can be aesthetically pleasing and also serve a useful function. It is apparent, however, that the subject device is not limited to the production of coffee mugs and can be used to produce many other designs and shapes including works of art."[154]
>
> "In designing a coffee mug, various options should be assembled as to the aesthetic and utilitarian preferences and this information should be encoded in the AAC. This can be done using a computer code which generates vertically aligned stripes of various lengths which together stimulate the profile or potential mug design."[155]

The lessons to learn from the US '666 patent are, firstly, that the "device", the dual ANNs structure, could at best generate the claimed invention, among others a coffee mug of a particular shape/function, "autonomously", if the notion of the invention is reduced to the final run of the "device". In other words, ignoring the formulation of the problem, its input into the "device", the selection, the provision of/access to the necessary training data, encoding the information on advanced audio-coding (AAC) using an appropriate computer code, etc., as decisive parts of the inventive concept.

What applies to the US '666 patent coffee mug applies even more to the DABUS food container. Thaler may have used the US '666 "device" or other patented devices referred to by him in the UK proceedings, or a combination of those devices, but could generate the claimed food container using them for the autonomous "final run" only with the necessary human input.

6.4. Description Requirements in AI Related Applications

In practical terms, more important, however, is the lesson that in times of highly developed AI technologies with numerous AI core and AI applied inventions, which can be used for assisting/solving technical problems practically across all fields of technology, require a thorough re-evaluation of what to consider the relevant prior art. Moreover, in connection with this also a reassessment of search and examination strategy and the notion of the fictitious person skilled in the art seems necessary. The DABUS food container applications in connection with the facts presented by Thaler in UK proceedings demonstrate this in an exemplary way.

The description in the DABUS EP '144 application departs from the disadvantages of prior art containers for food products. It asserts the invention is particularly suitable,

of acceptable and unacceptable coffee mug designs (ibid., column 3, lines 31-40; see also column 7, lines 18–48).

154 Ibid., column 7, lines 5-14.

155 Ibid., column 7, lines 49-54.

but not limited to, containers for liquids, such as beverages and other flowable products.[156] The description then continues:

> "According to an aspect of the present invention, there is provided a food or beverage container comprising: a wall defining an internal chamber of the container, the wall having interior and exterior surfaces and being of substantially uniform thickness; wherein the wall has a fractal profile with corresponding convex and concave fractal elements on corresponding ones of the interior and exterior surfaces; and wherein the convex and concave fractal elements form pits and bulges in the profile of the wall."[157]

The description of the preferred embodiments introduces as follows:

> "The concept disclosed herein makes use of a fractal profile for the wall of the container, which has been found to provide a number of advantageous characteristics when applied to a container particularly for food and beverage products. The skilled person will appreciate that the profile of the wall will not be of pure fractal form but will have a form dictated by practical considerations such as the minimum practical or desirable size of its fractal components. Nevertheless, the relationship between elements of the profile is fractal in nature. In practical embodiments, the fractal container may exhibit a fractal interpretation over two or more size scales."[158]

Because the person skilled in the art can realise the invention claimed in EP '144 based on the description and drawings, the enabling disclosure requirement is no problem and no additional information required. As a consequence that a patent grant is not conditioned upon disclosure of the way how the inventor arrived at the invention claimed, the EP '144 contains no information which could establish a link to the US '666 patent document or to other US patents referred to by Thaler in the UK proceedings, as possible alternative devices.[159] Also, the International Patent Classification (IPC) assigned by the USPTO to the US '666 "device" "autonomously" designing among others coffee mugs, i.e. beverage containers, does not suggest any relevance as potentially relevant prior art (published on 17 October 1997) for EP' 144, filed on 17 October 2018. The US '666 invention is classified in the IPC Cl. G 06E 1/00 (devices for processing data exclusively), G 06 E 3/00 (devices not provided for in-group G 06E 1/00, e.g. for processing analogue or hybrid data), and G 06F 15/18 (digital computers in general; data processing equipment in general—in which a programme is changed according to experience gained by the computer itself during a complete run; Learning machines, etc.). Therein is no hint or suggestion that an AI learning machine such as the dual ANNs structure of US '666

156 [0006] Column 2, line 3-6.

157 [0007] Column 2, lines 7-16.

158 [0019] Column 3, lines 26-47.

159 EP '144 does not cite a single document of this kind as reference.

specifically also discloses a method for "autonomously designing beverage containers of desired shape/function". The EP '144 is classified in the IPC Cl. B 65 D 6/00 (containers having bodies formed by interconnecting or uniting two or more rigid or substantially rigid, components made wholly or mainly of metal, plastics, wood or substitutes thereof), B 65D 8/00 (containers having a curved cross-section formed by interconnecting or uniting two or more rigid, or substantially rigid, components made wholly or mainly of metal, plastics, woods or substitutes thereof) and B 65D 21/02 (containers specially shaped or provided with fittings or attachments, to facilitate nesting, stacking or joining together).

The situation described reveals some deficiencies of the patent system as currently practised. Even to an ordinary person "in the art", as this writer, it appears that an adequate assessment of the inventive step involved in the DABUS food container invention should not ignore the US '666 patent document. Most probably also not those patent documents, to which Thaler referred to in the UK proceedings, but not examined here. An "artificial neural network discovery device" of the US '666 patent type, not only could, according to Thaler, did "design" the food container having a fractal profile. In the context of the inventive step requirement assessment, the decisive questions are, firstly, was it obvious to consider the US '666, an AI core invention whose use for designing, inter alia coffee mugs, i.e. beverage containers, had been prior art since August 1997, for designing beverage containers, and, secondly, was this obvious to a person skilled in the art? The answer to the first question seems relatively simple and should be a "yes", the second question is more difficult to answer. Under the given circumstances, even a skilled person in the art facilitated by AI technology tools would hardly identify, e.g. the US '666 patent document as prior art being worth closely considered.[160]

Independent of whether the "technical" assessment offered by an ordinary person stands scrutiny as regards the DABUS case, it should not be questioned that the US '666 and the EP '144 patent documents should offer more guidance to the fictitious person skilled in the art used by the examiner/court as the yardstick when assessing the inventive step requirement. Considering that the US '666 document claims and discloses a "device" inter alia for designing beverage containers, the document should also be classified in the IPC Cl. B 65D.[161] Moreover, applicants claiming inventions generated by the use of AI tools should refer in the application to the respective prior art documents, i.e., in the DABUS application, to the US '666 patent document, but also to other patents

160 The DABUS food container application offers an opportunity for testing whether a 'machine of ordinary skills' (MOSITA), which as Fabris assumes, "knows, through all the data it incorporates and by means of its computational capacity, all the existing prior art and all possible correlations, even in unrelated scientific fields." (D. Fabris, 2020, p. 692), would, based only on the description of EP '144, and without any further guidance, detect and consider US '666 patent document as potentially relevant prior art.

161 A subclass, which covers a broad range of containers.

referred to by Thaler in the UK proceedings. This clearly follows from the Rule 42 (b) EPC, under which applicants are obliged to indicate in the description:

> "[T]he background art which, as far as is known to the applicant, can be regarded as useful to understand the invention, draw up the European search report and examine the European patent application, and preferably *cite the documents reflecting such art*."[162]

Thaler, the applicant, expressly not only admitted that he was familiar with the US '666 patent document and other identified US patents, but even that he used a "device" of the US '666 type for designing/inventing the claimed food container.

7. Authorities in Search for Orientation

The extensive academic debates on the challenges of patent law paradigms by AI yielded some fruits and induced initiatives of some IP authorities.

7.1. USPTO

On 21 August 2019, Andrei Iancu, Undersecretary of Commerce for Intellectual Property and Director of the USPTO published in the Federal Register a "Request for Comments on Patenting Artificial Intelligence Inventions",[163] i.e. inventions that utilize AI, as well as inventions that are developed by AI. The USPTO requested comments on the following questions:

1. What are the elements of an AI invention? For example: the problem to be addressed (e.g. application of AI); the structure of the database on which the AI will be trained and will act; the training of the algorithm on the data; the algorithm itself; the results of the AI inventions through an automated process; the policies/weights to be applied to the data that affect the outcome of the result; and/or other elements.
2. What are the different ways that a natural person can contribute to the conception of an AI invention and be eligible to be a named 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?
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?
5. Are there any patent eligibility considerations unique to AI inventions?
6. Are there any disclosure-related considerations unique to AI inventions?

[162] Emphasis added [J.S.]. Cf. also e.g. R. Schulte and R. Moufang, 2017, § 34 marginal note 213.

[163] See *supra* n. 58.

7. How can patent applications for AI inventions best comply with the enablement requirement, particularly given the degree of unpredictability of specific AI systems?
8. Does AI impact the level of a person of ordinary skill in the art? If so, how?
9. Are there any prior art considerations unique to AI inventions?
10. Are there any new forms of intellectual property protections needed for AI inventions, such as data protection?
11. Are there any other issues pertinent to patenting AI inventions that we should examine?
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?

7.2. WIPO

On December 13, 2019, also WIPO started with what it calls 'Conversation on Intellectual Property (IP) and Artificial Intelligence (AI)'.[164] WIPO, like the USPTO Commissioner, invited a broad range of interested parties to submit comments on issues, which were phrased much along the same lines as those published by the USPTO in August of 2019. Taking into account the comments received, which in particular criticised the lack of clarifying definitions for the terms used in the December 2019 paper, WIPO in the framework of its IP/AI 'Conversation', on 21 May 2020, published a 'Revised Issues Paper on Intellectual Property Policy and Artificial Intelligence'.[165] The revised version defines *inter alia*, the terms 'artificial intelligence', 'AI-generated' and 'generated autonomously by AI'.

As regards the 'AI', WIPO, on the one hand, defines it in a comprehensive sense as

> "A discipline of computer science that is aimed at developing machines and systems that can carry out tasks considered to require human intelligence, with limited or no human intervention."[166]

However, WIPO immediately clarifies that for the purpose of this paper,

> "AI generally equates to 'narrow AI' which is techniques and applications programmed to perform individual tasks."[167]

The Paper further clarifies that it uses the terms *'AI-generated'* and *'generated autonomously by AI'* interchangeably and that those terms refer to the generation of output by AI without human intervention. Thereby, 'without human intervention', meaning that AI can change its behaviour during operation to respond to unanticipated information

164 Doc. WIPO/IP/AI/2/GE/20/1.

165 Doc. WIPO/IP/AI/2/GE/20/1 Rev.

166 Ibid., No. 11.

167 Ibid. According to WIPO, Machine Learning and Deep Learning are two subsets of AI.

or events. This, according to the paper, is to be distinguished "from 'AI-assisted' outputs that are generated with material human intervention and/or direction".[168]

Although the rephrased "Questionnaire", for which WIPO is seeking comments in the area of patents, starts with asking whether the law should "define the line between AI-generated and AI-assisted output", and, if so, "how much human input should be considered material", the following questions actually address predominantly issues specific to AI inventions generated autonomously, i.e. without human intervention. The reason is WIPO's understanding that inventions in which AI assists inventors in the inventive process or constitutes a feature of an invention "might not differ radically from other computer-implemented inventions".[169]

WIPO has subdivided its questions into five groups, called "issues". They relate to "Inventorship and Authorship", "Patentable Subject Matter and Patentability Guidelines", "Inventive Step or Non-Obviousness", "Disclosure" and "General Policy Considerations for the Patent System". Each issue is subdivided into several specific questions, which cover a very broad range of aspects. In the case of "Inventorship and Authorship", e.g. whether AI-generated-inventions at all required patent protection or a similar incentive system, should they require that a human being be named as the inventor or should the law permit an AI application to be named as the inventor, and what consequences should the law set forth in either case.[170] As regards the patentable subject matter, should the law exclude from patent eligibility AI-generated inventions or should they be treated the same way as the other computer-implemented inventions, or should they require specific provisions? Should AI applications or algorithms be considered computer programs or software?[171] In case of inventive step or non-obviousness, should the present standard of the person skilled in the art be maintained or replaced by an AI application trained with specific data from a designated field of prior art? Should AI-generated content qualify as prior art?[172] As regards the disclosure, whether in the case of machine learning, it should suffice to disclose the initial algorithm, "where outcomes may change depending on the input data and the algorithm adjusts the weights associated with neuron connections to reconcile the differences in actual and predicted outcome?" Further, "Would a system of deposit for AI applications or training data, similar to the deposit of microorganisms, be useful?".[173]

7.3. Feedback to the USPTO Request for Comments

168 Ibid., No. 12.

169 Ibid., No. 16.

170 Cf. for details ibid, No. 17.

171 For more see ibid, No. 19.

172 Cf. ibid., No. 20.

173 Cf. ibid., No. 21.

The USPTO received upon its request of August 2019 altogether 99 comments, 2 from foreign patent offices (EPO and JPO), 9 from Bar associations, 13 from trade associations/advocacy groups, 13 from companies, 13 from academia, 2 from law firms, 14 from practitioners (other than firm or academia submissions), and 33 from individuals.[174] As the most general outcome of the comments received, the synthesis of the responses prepared by the USPTO experts reveals that according to the majority of public commenters, the current state of the art is limited to 'narrow' AI, and AGI has not yet arrived. Moreover, that the "current AI could neither invent nor author without human intervention", and "that human beings remain integral to the operation of AI". Finally, that the existing US intellectual property laws are calibrated correctly to address the evolution of AI.[175] In detail, the commenters expressed the following views.

The majority of replies to *Question 1*, 'What are the elements of an AI invention?', in line with the JPO practice,[176] distinguished two AI inventions categories. On the one hand, inventions that embody an advance in the field of AI (e.g. a new neural network structure of an improved ML model or algorithm), and on the other hand, inventions that apply AI (to a field other than AI).[177] Some commenters added as a separate category "Inventions that may be produced by AI itself."[178]

As regards *Questions 2* and *3*, addressing the eligibility of a natural person as an inventor in AI inventions, the feedback of the vast majority of public commenters was overall consistent. They asserted that the current inventorship law was equipped to handle the inventorship of AI technologies.[179] Moreover, that there is no need for revising patent laws and regulations on inventorship to account for inventions in which an entity or entities other than a natural person contributed to the conception of an invention.[180] The USPTO itself clarified that

> "The use of an AI system as a tool by a natural person(s) does not generally preclude a natural person(s) from qualifying as an inventor (or joint inventors) if the natural person(s) contributed to the conception of the claimed invention. That is, the activities by a natural person(s) that would ordinarily qualify as a contribution to the conception of an invention are unaffected by the fact that an AI system is used as a tool in the development of the invention. For example, depending on the specific facts of each case, activities such as designing the architecture of the AI system, choosing the specific data to provide to the AI system, developing the

[174] USPTO, *Public Views on Artificial Intelligence and Intellectual Property Policy*, Washington D.C. (USPTO Public Views), October 2020, Table 1 at p. i.

[175] Ibid., p. ii–iii.

[176] See *supra* section 4.3, text accompanying n. 58.

[177] USPTO Public Views, p. 1 and footnote 4.

[178] Ibid., p. 2 and footnote 5.

[179] Ibid., p. 3 and footnote 12.

[180] Ibid., p. 5 and footnote 24.

> algorithm to permit the AI system to process that data, and other activities not expressly listed here may be adequate to qualify as a contribution to the conception of the invention."[181]

Some commenters expressed the view that, once AI has reached the step of AGI, the USPTO should take up the issue again.[182]

In response to *Question 4*, the vast majority of respondents expressed the view that only a natural person or a company, based on assignment, as set forth in the current US law, were the owner of a patent or an invention.[183] However, the Intellectual Property Owners Association (IPO) argued, "a natural person who trains the AI process that creates an AI-generated invention should be able to be an owner".[184] IBM argued that once machines become capable of inventions, "their inventions and the corresponding patents should be owned by those that own them"; and Siemens suggested that the right of the inventors be extended "to legal persons controlling the Al systems".[185]

According to the feedback received by the USPTO to *Question 5*, whether there were patent eligibility considerations unique to AI inventions revealed the understanding that AI inventions do not require any different treatment than other computer-implemented inventions.[186] In other words, a treatment in line with the USPTO current practice. As to the problems, which may result from the Alice/Mayo doctrine, the USPTO referred to one commenter who noted that "complex algorithms that underpin AI inventions have the ability to yield technological improvements".[187] The USPTO further added that

> "claims directed to an abstract idea will still be patent-eligible if the additional claim elements, considered individually or as an ordered combination, amount to significantly more than the abstract idea so as to transform it into the patent-eligible subject matter."[188]

In its introductory comment on disclosure-related considerations (*Question 6*), the USPTO emphasised that under 35 U.S.C. § 112(a), applications for AI inventions that include claims to computer-implemented inventions that recite functional language,

> "should provide sufficient detail in the specification regarding the hardware, as well as software, to show that the inventor had possession of the full scope of the claimed invention. In particular, the specification should disclose the computer and the algorithm (e.g., detailed steps or procedures, formulas, diagrams, and/or

[181] Ibid., p. 5.

[182] Ibid., p. 6 and footnotes 27-30.

[183] Ibid., p. 7 and footnote 35.

[184] Ibid., p. 7, footnote 36.

[185] Ibid., p. 7, footnote 37.

[186] Ibid., p. 8.

[187] Ibid. (for the Alice/Mayo doctrine see *supra* section 4.5, text accompanying footnotes 76–85).

[188] Ibid.

flowcharts) that perform the claimed function in sufficient detail such that one of ordinary skill can reasonably conclude that the inventor possessed the claimed subject matter."[189]

Despite the complexity of AI inventions, according to the USPTO, the majority of commenters "shared the sentiment that there are no unique disclosure considerations for AI inventions".[190] The USPTO only referred to the comment of IBM, noting that "AI inventions can be difficult to fully disclose because even though the input and output may be known by the inventor, the logic in between is in some respects unknown".[191] Thus, according to the USPTO, the characteristics of AI learning systems may "drive further discussions".[192]

Less pronounced were the commenters regarding *Question 7* dealing with the enablement requirement of 35 U.S.C. § 112(a), which, under the settled case-law, constitutes a patentability requirement distinguished from that of written description. Whereas the first requires that the inventor possessed the claimed subject matter at the filing/priority date, the second is satisfied when the specification teaches one of ordinary skill in the art how to make and use the full scope of the claimed invention without undue experimentation.[193] Based on a decision of the Court of Appeals for the Federal Circuit (CAFC), *In re Wands*,[194] the MPEP has developed the so-called Wands factors. They include: breadth of claims, nature of the invention, state of the prior art, level of one of ordinary skill, level of predictability in the art, amount of direction provided by the inventor, existence of working examples, and quantity of experimentation necessary to make or use the invention based on the content of the disclosure.[195] According to the MPEP,[196] the amount of guidance or direction is inversely related to the amount of knowledge in state of the art, as well as the predictability in the art. The feedback of commenters to this question did seemingly not provide for a clear majority view. The USPTO, e.g., refers specifically to the IBM comment noting that some AI inventions may operate in a black box because there is an "inherent randomness in AI algorithms".[197] Moreover, to the reply of

[189] Ibid., p. 9.

[190] Ibid.

[191] Ibid., p. 10 and footnote 49.

[192] Ibid.

[193] See MPEP § 2164.01.

[194] 858 F.2d 731 (Fed. Cir. 1988).

[195] See MPEP § 2164.01 (a).

[196] § 2164.03.

[197] Ibid., p. 11 and footnote 58. Ibid, p. 11 and footnote 58. As regards the 'black box' issue, Ménière and Pihlaiamma, two high EPO officers, argue that the inability of users to explain why the AI algorithm favours a specific decision in case of inventions based on iterative learning capability, does not present a challenge for meeting the disclosure requirement under Article 83 EPC. Where the decision-making process takes place in a 'black box' it were, as a rule, possible for the expert to

the American Intellectual Property Law Association (AIPLA) stating that "most current AI systems behave in a predictable manner and that predictability is often the basis for the commercial value of practical applications of these technologies".[198] Finally, to the response from Genentech, suggesting that because of the greater degree of unpredictability associated with AI-based inventions, the written description requirement and the enablement factors from *In re Wands* should apply.[199]

As regards the potential of AI to alter the skill level of the hypothetical ordinary person skilled in the art and thus affect the bar for the assessment of nonobviousness (*Question 8*), many commenters, among them the EPO, JPO, Genentech, IBM and Siemens, asserted such a potential.[200] However, numerous commenters, among them Novartis and Merck, suggested that the present legal framework for assessing the person of ordinary skill in the art were "adequate to determine the impact of AI-based tools in a given field" and should remain unchanged.[201] The fact that the USPTO verbatim reproduced the following comment of an individual commenter

> "Just as the existence of test tubes impacts the level of a person of ordinary skill in the chemical arts, and just as the existence of general-purpose computers impacts the level of a person of ordinary skill in the software arts (and many others), so [too] would AI affect the level of skill in the arts where it can be made useful"[202]

may be understood as a hint at the future practice of the USPTO, meaning that the use of pertinent AI tools will become, in appropriate cases, an inherent characteristic of the person skilled in the art for his/her assessment of nonobviousness.

The feedback to *Question 9*, as summarised by the USPTO, may convey the impression of quite diverging responses. However, the fact that "The majority of commenters stated that there were no prior art considerations unique to AI inventions – that current standards were sufficient",[203] does not necessarily mean that they entirely disagree with the views expressed by minorities. Some minorities' views opined that there were such considerations without specifying them. Others identified them in the generation of the

reproduce the results of an AI algorithm based on the disclosure of the algorithm and the training data, available to the applicant. They add that the EPO practice decides the enabling disclosure requirement on case-by-case basis, taking into account also the specifics of the technical field, such as biotechnology or chemistry, where the disclosed subject matter has a momentum (see Y. Ménière and H. Pihlaiamma, 2019, p. 335).

198 Ibid., p. 11 and footnote 56.

199 Ibid., p. 11 and footnote 59.

200 Ibid., p. 12 and footnote 67.

201 Ibid., p. 12 and footnote 68.

202 Pp. 12-13 and footnote 70.

203 Ibid., p. 13 and footnote 74 (among the respondents were Ericsson, Genentech and Siemens).

prior art by AI, potentially resulting in its proliferation[204] or difficulty in finding prior art, such as source code related to AI.[205] On the other hand, the minorities' comments do not imply that they would not regard current standards sufficient. It all depends on the understanding of "prior art considerations unique to AI". That there is a common understanding that using AI tools has an impact on relevant prior art transpires from the emphasis commonly expressed by the respondents, that training of examiner and providing examiners with additional resources for identifying and finding AI-related prior art were of great importance.[206]

The replies USPTO received to *Question 10*, whether a need exists for any new forms of IP for protecting AI inventions, e.g. data protection, reflected two opposite views. Some commenters viewed the current US IP framework as adequate. Others, however, suggested a need also to protect the data associated with AI, particularly ML.[207] In its reply, AIPLA suggested balancing the competitive advantage of large technology companies with huge data collections by a mechanism providing access to their data repositories. Such a mechanism should, on the one hand, protect proprietary rights to the data but, on the other hand, enable new market entrants and others to use such data to train and develop their AI.[208] IBM drew attention to potential IP protection gaps "for the trained model and its associated coefficients".[209]

In view of the huge investments in human and financial resources of pharmaceutical companies in the already successful use of AI tools, it does not come as a surprise that they manifested interest in alternative IP protection forms for specific types of data. Genentech, for instance, suggested that "some alternative, *sui generis* form of protection might be required to ensure that bioinformatics and other practical applications of AI in biotechnology are protected forms of intellectual property".[210] Novartis suggested to consider new forms of IP, including an IP right for trained models and "an IP right for nonpublic data, where its generation required substantial effort and investment (similar to the regulatory data protection [RDP] rights available in [the] industry for proprietary clinical and other data submitted to FDA and other regulatory authorities)", should the current system of protection prove inefficient to provide adequate incentives to sufficiently effectuate the promise of AI.[211]

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204 Ibid., p. 14 and footnote 76 (IBM argued: "AI will dramatically expand the scope of prior art available. First and foremost, AI has the capability of generating a tremendous amount of prior art.").

205 Ibid., p. 14 and footnote 77.

206 Ibid., p. 14 and footnote 79.

207 Ibid., p. 15.

208 Ibid., p. 15 and footnote 80.

209 Ibid., p. 15 and footnote 81.

210 Ibid., p. 16 and footnote 85.

211 Ibid., p. 16 and footnote 86.

As a reaction to *Question 11*, related to other issues, which the USPTO should examine, the commenters once more stressed the need for examiner technical training and examiners guidance specific to AI.[212]AIPLA pointed that "AI [created] inventions may require substantial changes in traditional legal approaches and frameworks, including notions of property, ownership, and other non-IP legal principles akin to the development of corporate law as we know it today".[213] Some individual commenters also stressed that the USPTO should also "consider the economic and scientific risks of granting patents to AI algorithm inventions and basic research that may have the potential to become foundational".[214]

8. Summary and Outlook

The answer to the question raised in the title of this contribution, whether AI will change some patent law paradigms, seemingly depends entirely on whose position one follows. On the one hand, the main patent offices seem confident they can adequately handle AI core inventions, as well as AI-applied inventions,[215] based on the existing legal instruments. Moreover, the patent offices, without exception, accept only a natural person as an inventor, and a natural or legal person as a patent owner, without explicitly addressing the issue of inventions autonomously generated by AI. Patent authorities see no necessity to alter current standards determining either the prior art, the person skilled in the art (of ordinary skill), or those of the enabling disclosure requirement. Although they acknowledge that AI-generated data may/will increase the amount of data forming prior art to search and consider when assessing novelty and inventive step, they seemingly assume that the use of pertinent AI tools will become, in appropriate cases, an inherent characteristic of the person skilled in the art.[216] The results of the USPTO 2019 Request for Comments show that the majority of public commenters, among them many industry-leading players in AI, favourably assess the practice of the USPTO in the AI area. According to them, the current state of the art is limited to 'narrow' AI, and AGI has not yet arrived. They argue that the AI currently could not invent without human intervention and "that human beings remain integral to the operation of AI". Finally, that the existing U.S. IP laws are calibrated correctly to address the evolution of AI,[217] in other words, the patent granting authorities and the majority of the main users of the patent system in the field of AI, at least for the time being and for the foreseeable future

212 Ibid., p. 16.

213 Ibid., p. 17 and footnote 90, where also similar comments of the EPO are reproduced.

214 Ibid., p. 17, e.g. footnote 91.

215 For definitions see *supra* text accompanying n. 58.

216 See *supra* text accompanying n. 202.

217 See *supra* text accompanying n. 175, 179–181.

do not see AI radically changing the patent law paradigms. They view the system as flexible enough to adapt to changes the AI developments generate in an evolutionary way. Available patent statistics seem to confirm these findings.[218]

Very similar results have been produced by an extensive Report commissioned by the EU Commission, accomplished in September 2020,[219] aimed at examining the state of copyright and patent protection in Europe for AI-assisted outputs in general[220] and in three priority domains: Science (in particular meteorology), media (journalism) and pharmaceutical research, as regards the EPC and the EPO practice. The Report reached, *inter alia*, the following conclusions:

> "– The EPC is currently suitable to address the challenges posed by AI technologies in the context of AI-assisted inventions or outputs.
>
> – While the increasing use of AI systems for inventive purposes does not require material changes to the core concepts of patent law, the emergence of AI may have practical consequences for national Intellectual Property Offices (IPOs) and the EPO. Also, certain rules may in specific cases be difficult to apply to AI-assisted outputs and, where that is the case, it may be justified to make minor adjustments."[221]

On the other hand, a growing number of academics and some AI (technical) experts, like Thaler and Koza—launching trial balloons by filing patent applications with machines labelled as inventors, argue precisely the opposite. Based on their understanding that AI algorithms and AI systems have since long autonomously, i.e. without human intervention, generated patentable inventions, they argue that AI requires a more or less radical change of all patent law paradigms.[222] What they interpret as largely autonomous inventive activity of AI-applications in some areas of R&D, where they apparently represent already daily routine, Tim W. Dornis recently illustrated by an example in which the AI activity uses algorithms in the search for pharmaceutically active substances, e.g. a therapeutics with specific properties. He argued as follows:

> "The person formulates the problem, finding a substance with specific characteristics. The AI in search of the substance. This is carried out for instance through an

[218] See *supra* section 4.1 and the text accompanying n. 70. The USPTO published more than 27.000 AI related patent applications since 2017, of which more than 16.000 within the past two years (https://www.uspto.gov/initiatives/artificial-intelligence) (last accessed 24 November 2020).

[219] J. Allan, 2020.

[220] The Report makes it clear from the outset: "While AI systems have become – and will become – increasingly sophisticated and autonomous, this Report nonetheless assumes that fully autonomous creation or invention by AI does not exist, and will not exist for the foreseeable future." (Ibid., p. 6).

[221] Ibid., p. 120.

[222] See *supra* sections 5.2 and 6.

> alignment with data banks and simulated algorithm test series as regards biochemical and medicinal effect of potentially suitable substances."[223]

Of course, Dornis adds, selecting subsequently among various identified active ingredients could constitute a human inventive contribution. However, if the result of AI were only a few or only even one suitable active ingredient, the AI alone had delivered the solution and performed the inventive activity.[224]

It transpires from the reference in footnote 80,[225] that Dornis for his illustration of an autonomous AI invention relied on an article titled "KI entdeckt vielversprechendes Antibiotikum" ("AI discovers a very promising antibiotic") authored by the freelance journalist Julia Merlot. Had Dornis consulted the original research paper "A Deep Learning Approach to Antibiotic Discovery" co-authored by Jonathan M. Stokes and 19 other researchers,[226] he had realised that the solution in the case he indirectly referred to by no means falls in the category of "inventions without inventors" (*Erfindungen ohne Erfinder*) and by no means were public domain.[227] A short quotation from the "Cell" paper describing the discovery in connection with Figure 1 should suffice to understand that the AI has not autonomously discovered the antibiotic and that humans by no means were involved only in formulating the problem and after the actual discovery, selecting the suitable antibiotic. The authors, potential co-inventors, summarised their discovery as follows:

> "Our deep neural network model works by building a molecular representation based on a specific property, in our case the inhibition of the growth of E. coli, using a directed message passing approach. We first trained our neural network model using a collection of 2.335 diverse molecules for those that inhibited the growth of E. coli, augmenting the model with a set of molecular features, hyperparameter optimization and ensembling. Next, we applied the model to multiple chemical libraries, comprising >107 million molecules, to identify potential lead compounds with activity against E. coli. After ranking the *candidates* according to the model's predicted score, we selected a list of promising candidates."[228]

This clarification and rectification seem necessary because Dornis' argumentation method seems symptomatic for at least a part of those writers who claim that AI autonomously generates patentable inventions without going into any technical details. How to

223 T.W. Dornis, 2020, p. 443 (rough English translation from German, J.S.).

224 Ibid., pp. 443–444.

225 Ibid., p. 443.

226 See *supra*, n. 29 and the accompanying text.

227 T.W. Dornis, 2020, p. 444.

228 J.M. Stokes et al., 2020, Figure 1 and accompanying text at p. 689. Enlightening is also a comment made by Nathan Benaich, 2020. For the decisive human involvement in the recent successful cases of AI, e.g. "AIs Direct Search for Materials" and "AI Designs Organic Synthesis", the analysis made, *supra* text accompanying n. 34–38, is recalled.

perform a serious analysis of the role of human intervention in the case of AI used in drug discovery or in AI-augmented target identification transpires from the Report "Trends and Developments in Artificial Intelligence". The Report offers a detailed analysis of two real-world cases and specifically identifies the decisive steps of human intervention.[229]

Daria Kim has correctly observed that patent literature asserting AI systems as autonomous generators of patentable inventions "refers to a handful of examples without providing or referencing a technical analysis, which could explain how the 'intelligent systems' were designed, and how the overall computational process leading to an invention was set up".[230]

Considering the broad range of commenters from all over the world who reacted to the USPTO Survey, it seems safe to assume that the patent laws in force and the patent granting practice in the area of AI, not only in the US but also beyond, is viewed adequate and does not require any legislative changes. A consensus seems to exist that only a natural person can be an inventor[231] and that machines, at least at this stage and for the foreseeable time, do not and will not autonomously generate patentable inventions.[232] Moreover, that patent law provisions adequately regulate the patentability requirements. Whether one day "everything" will become obvious, as augured by Ryan Abbott,[233] will primarily depend on how the notion of patentable invention is defined. If it is narrowed down to the final run in the "problem-solution" chain of an inventive process, an adequately equipped fictitious person skilled in the art may reach such a result in the majority of cases.

229 *Supra* n. 220, pp. 38–43.

230 D. Kim, 2020, p. 444.

231 The complexities of an AI applied invention, however, imply that more often than in the past more persons may contribute to the final output of the AI system, and may claim and be entitled to own or co-own the invention, thus the patent. That could apply to the programmer(s) of the AI system, or/and to the person(s) who trained the machine (those in charge of dataset selection or creation, supervision of the learning process or reinforcement training). This could equally apply to the owner of the system who may have risked capital to produce the output, including the cost of developing the AI system, e.g. obtaining the input training data, developing the operational logic model(s) and the learning process, as well as turning outputs into applications. The resolution of disputes related to inventorship and ownership issues is a matter for national courts applying national laws (J. Allan, 2020, p. 105).

232 Also, experts in AI and robotics caution "that characteristics such as 'autonomous', 'unpredictable' and 'self-learning' are 'based on an overvaluation of the actual capabilities of even the most advanced robots, a *superficial* understanding of unpredictability and self-learning capacities [...], a robot perception distorted by science-fiction and a few recent sensational press announcements." (Open Letter to the European Commission. Artificial Intelligence and Robotics, para. 2, <http://www.robotics-openletter.eu> (last accessed 10 August 2020) (emphasis added) (quoted from D. Kim, 2020, at p. 444).

233 R. Abbott, 2019.

However, the feedback to the USPTO Survey and the cautious findings in the Report commissioned by the EU Commission,[234] strongly suggest that patent offices should intensify their efforts to adequately train examiners and provide them with AI tools necessary to perform novelty and inventive step searches effectively in an ever-increasing and extremely diverse available prior art. As the analysis of the DABUS application undertaken in this contribution also demonstrates, this will also require new search strategies for examiners, including detailed guidance for awarding the cross technologies IPC classifications. In addition to examination guidelines, also amendments of implementing regulations may be necessary to provide for stricter disclosure obligations as regards the description standards. Applicants like Thaler should be obliged to disclose and cite such patent documents as the US '666 because only then could examiners effectively detect and assess the relevant prior art. The practical consequence of such measures will not "raise" the non-obviousness requirement bar, as often observed, rather it will provide for the necessary adjustments of the capabilities of the fictitious "person skilled in the art" to those of researchers/inventors assisted by AI tools. In other words, make sure that the agreed standards remain effective. Because inventors, such as Thaler, are using in their search for technical solutions AI tools, which have the power to render inventions predictable and obvious,[235] only restored equality of arms on the side of the "skilled person in the art", the benchmark for assessing inventive step, can prevent granting patents for obvious research results.

At last, the issue of the enablement of AI-related inventions deserves some thought. As reported, IBM, in its feedback to the USPTO Survey, observed that some AI inventions could operate in a black box "because there is an inherent randomness in AI algorithms".[236] The resulting inability of users to explain why the algorithm favours a specific decision in case of inventions based on iterative learning capability, according to EPO experts, does not present a challenge for meeting the disclosure requirement under Article 83 EPC. This was so because the experts, as a rule, can reproduce the results of an AI algorithm based on the disclosure of the algorithm and training data available to the applicant.[237] Nonetheless, it appears necessary that disclosure of such information is explicitly required either in the examination guidelines or even in the implementing regulations. Access to the training data is a crucial aspect of ensuring the reproducibility of an invention. Therefore, the disclosure of such data should be made mandatory.[238]

[234] J. Allan, 2020.

[235] Cf. R. Clifford, 2018, p. 36.

[236] *Supra* n. 34.

[237] Y. Ménière and H. Pihlaiamma, 2019, p. 335.

[238] As discussions in the scientific literature reveal, reproducibility of AI inventions presents an issue of great technical and legal complexity. This because proprietary rights of third parties in the data may be involved and constitute an obstacle for their disclosure (cf. B. Haibe-Kains, et al., 2020, pp. E14-E16; and S.M. Mckinney, et al., 2020, p. E17).

If necessary, the introduction and establishment of a depository system similar to that existing for biological material[239] may offer a practicable solution for data access.

It transpires from the results of the overall feedback to the USPTO Survey, the position taken by the key patent offices and the conclusions reached by the Report "Trends and Developments in AI",[240] that the legal framework currently enabling/controlling the grant of patents for AI-related inventions is adequate. Nonetheless, also the need for fine-tuning, including some important adjustments to the changing technological environment, is felt. However, for achieving the necessary adjustments, no legislative actions are required.

A suggestion made by the Committee on Legal Affairs of the European Parliament in its Report on Intellectual Property Rights for the Development of Artificial Intelligence Technologies (2020/2015 (INI))[241] runs in the directly opposite direction. This Report proposes to create an operational and fully harmonised regulatory framework in the field of AI technologies in the form of a regulation to avoid fragmentation of the European digital single market and promote innovation.[242] The motives of this suggestion are certainly laudable,[243] and some reasons are given convincing. Nonetheless, the idea may not stand scrutiny. An attempt to successfully draft a regulation, which should take into account, for example, the degree of human intervention, the autonomy of AI, the importance of the role and the origin of the data[244] and wrap these and other sophisticated considerations in a legally binding and enduring, but flexible form, seems nearly mission impossible. This would lead to protracted and controversial discussions within different EU fora and unnecessarily politicise the topic. The unavoidable long-lasting discussions would generate legal uncertainty, i.e. precisely the opposite of intended and could eventually even fail.[245] Applicants, with rare exceptions, file applications for AI related inventions, with the EPO, which ensures a centralised and harmonised patent granting practice. The widely accepted EPO case law as regards computer-implemented inventions, including those AI-related, is a result of a decision of the EPO Enlarged Board of Appeal of May 10, 2010. Therein the Board rejected the Referral of the President as inadmissible because it could not identify any inconsistencies in the case-law of different Boards of Appeal as regards the patent-

[239] See for details J. Straus, 2019, pp. 546–554, with further references.

[240] *Supra* n. 220.

[241] PE650.527v02-00, A9 - 0176/2020, published on 2 October 2020.

[242] Ibid., no. 3 at p. 6.

[243] The Report critically notes that in the EU Commission's "White Paper" (*supra* n.1) "the issue of the protection of IPRs has not been addressed by the Commission, despite the key importance of these rights" (ibid, no.1 at p.6).

[244] Ibid., no. 10, p. 7.

[245] As it happened with the Proposal for a Directive of the European Parliament and of the Council on the patentability of computer-implemented inventions of 2002, which, after protracted controversial discussions, was rejected by the European Parliament in July of 2005 (COM (2002) 92 final – 2002/0047 (COD)).

ability of computer-implemented inventions, as alleged by the President. However, the Board used prudently the opportunity to circumscribe the frame of patent eligibility for computer-implemented inventions under the European Patent Convention.[246]

Prophets predicting that it is "only a matter of time until computers are responsible for most inventions",[247] are reminded of the fate of e.g. the 1930 prediction that "possibly Edison may be the last of the great heroes of invention."[248] To the great benefit of humanity, in reality, numerous great heroes of the invention followed Edison and the prospect that many more will follow him, no fantasy. AI technology has an impact on the patent law paradigms, but as in case of other revolutionary and disruptive technologies preceding AI, it is an impact leading to evolutionary adaptations of their prerequisites. Whether the paradigm that only a natural person can be a "statutory" inventor could one day require a radical change will largely depend on the evolutionary adaptations of other patent law paradigms to the development of AI technologies. The understanding/definition of the patentable invention—inventive concept, and the inventive step, the non-obviousness standard will be crucial, because they will control the question, whether a technical solution entirely autonomously, i.e. from the scratch generated without any human intervention by an AI tool, can in principle fulfil all the patentability requirements.

Until that stage is reached, academic lawyers developing high flying thought for solving problems resulting from inventions "autonomously" generated by AI should overcome their resistance to read and study original research papers reporting on achievements involving AI and the respective patent documents,[249] instead to rely on reports of freelanced journalists in scientific or even popular journals.

References

2019 Revised Patent Subject Matter Eligibility Guidance (PEG), Federal Register – *The Daily Journal of the United States Government,* <https://www.federalregister.gov/documents/2019/01/07/2018-28282/2019-revised-patent-subject-matter-eligibility-guidance> (last accessed 31 August 2020).

Abbott, R. (2016) 'I Think, Therefore I Invent: Creative Computers and the Future of Patent Law', *Boston College Law Rev.*, 57, 4, pp. 1079–1126.

246 G 3/08, OJ EPO 2011, p.10.

247 R. Abbott, 2016, p. 1080.

248 W. Kaempffert, 1930, p. 30, quoted from R. P. Merges, 2020, p. 111.

249 Reading patent documents, however, does not mean to quote a paragraph from the respective patent application. R. Deshpande and K. Karmath, 2020, pp. 879–884, for instance, based on what Thaler contended in its DABUS USPTO patent application (recited at p. 882), without going into any technical details decisive for the assessment, take it for granted that the DABUS machine autonomously generated the invention.

Abbott, R. (2019) 'Everything is Obvious', *UCLA L Rev.*, 66 (2), pp. 2–52.

Allan, J. (ed.) (2020) *Trends and Developments in Artificial Intelligence: Challenges to the Intellectual Property Rights Framework*, Luxembourg: European Union Publisher.

Benaich, N. (2020) 'Why Artificial Intelligence has disappointed in the Pandemic?', *Financial Times*, 21 September, p. 21.

Bonadio, E., McDonagh, L., and Dinev, P. (2021) 'Artificial Intelligence as Inventor: Exploring the Consequences for Patent Law', *I.P.Q.*, Issue 1, pp. 48–66.

Bratko, I. (1994) 'Machine Learning and Qualitative Reasoning', *Machine Learning* 14, pp. 305–312.

Clifford, R.D. (2018) 'Creativity Revisited', *IDEA*, 59, pp. 25–39.

Committee of Legal Affairs of the European Parliament, Report on "Intellectual Property Rights for the Development of Artificial Intelligence" of 2 October 2020, Explanatory Statement, pp. 12–13, PE650.527v02-00, A9 – 0176/2020, on 2 October 2020.

Committee of Legal Affairs of the European Parliament, *Report on "Intellectual Property Rights for the Development of Artificial Intelligence" of 2 October 2020*, Explanatory Statement, pp. 12–13 (Doc. PE650.527v02-00, A9 - 0176/2020).

Court of Appeals for the Federal Circuit, *In re Wands*, 858 F.2d 731 (Fed. Cir. 1988).

Decision of the EPO of 27 January 2020, rejecting the application No. 18275174.3 (under No. I, 1-5) (EPO Doc. PK23498), <https://www.epo.org/news-events/news/2020/20200128.html> or <https://data.epo.org/publication-server/pdf-document?pn=3563896&ki=A1&cc=EP&pd=20191106> (last accessed 17 August 2020).

Deshpande, K. Karmath (2020) 'Patentability of Inventions created by AI – the DABUS claims from an Indian perspective', *JIPLP*, Vol. 15, No. 11, pp. 879–884.

Dornis, T.W. (2020) 'Künstliche Intelligenz als "Erfinder" – Perspektiven der Disruption im Patentrecht', *Part I, Mitteilungen der deutschen Patentanwälte*, pp. 436–446.

England and Wales High Court (Patents Court), Decision of the of 21 September 2020 – *Stephen L Thaler v. the Comptroller-General of Patents, Designs and Trade Marks* ([2020] EWHC 2412 (Pat)), para. 7.

EPO (2020) *Patents and the Fourth Industrial Revolution: The Global Technology Trends Enabling the Data-Driven Economy*, Munich, December.

EPO Enlarged Board of Appeal, G 3/08, OJ EPO 2011, 10.

EPO Patent Index 2020 (2020) Boom in Digital Technologies Continues, <https://www.epo.org/about-us/annual-reports-statistics/statistics/2020/digital-technologies.html> (last accessed 13 April 2021), p. 4.

EPO Examination Guidelines Part G-II, 3.6, with references to the EPO case law. The Committee on Legal Affairs of the European Parliament in its Report on Intellectual Property Rights for the Development of Artificial Intelligence Technology (2020/2015/INI) of 2 October 2020 (PE650.527v02-00, A9 - 0176/2020).

European Commission, *White Paper on Artificial Intelligence – A European Approach to Excellence and Trust*, February 2020, COM (2020) 65 final, p. 2.

Fabris, D. (2020) 'From the PHOSITA to the MOSITA: Will 'Secondary Considerations' Save Pharmaceutical Patents from Artificial Intelligence?', *IIC* 51, pp. 685–708.

Ferragina, P., and Luccio, F. (2018) *Computational Thinking, First Algorithm, then Code*, Berlin: Springer.

Gen, M., and Lin, L. (2009) 'Evolutionary Techniques for Automation, in: Nof, Sh. (ed.), *Springer Handbook of Automation*, Berlin: Springer, pp. 487–502.

Greenberg, A. (2020) 'Protecting Virtual Things: Patentability of Artificial Intelligence Technology for the Internet of Things', IDEA 60 (2), pp. 329–337.

Gurkaynak, G., Yilmaz, I. and Haksever, G. (2016) '*Stifling Artificial Intelligence: Human Perils*', *Computer Law & Security Review*, 32, pp. 749–758.

Haibe-Kains, B. et al. (2020) 'Transparency and Reproducibility in Artificial Intelligence', *Nature*, 586, pp. E14-E16.

Higgins, B. (2019) 'The Role of Explainable Artificial Intelligence in Patent Law', *Intellectual Property & Technology Law Journal*, Vol. 31, No. 3, March, pp. 3–8.

Ireland, I., and Lohr, J. (2020) "DABUS': The AI Topic that Patent Lawyers Should be Monitoring', *Managing IP.com*, Autumn, pp. 23–25.

Japan Patent Office Administrative Affairs Division (2019) Comments to Patenting Artificial Intelligence Inventions submitted by the Examination Standards Office, of September 2019 to the United States Patent and Trademark Office (USPTO), *Request for Comments on Patenting Artificial Intelligence Inventions* of 21 August 2019, Federal Register/Vol. 84, No. 166 of 27 August 2019/ Notices 44889.

Jin, H.R. (2018) 'Think Big! The Need for Patent Rights in the Era of Big Data and Machine Learning', *Journal of Intellectual Property and Entertainment Law*, 7, Spring, pp. 78–110.

JPO Examination Guidelines, <https://www.jpo.go.jp/e/system/laws/rule/guideline/patent/tukujitu_kijun/document/index/03_0100_e.pdf> (last accessed 18 August 2020).

JPO Patent Examination Department (Electronic Technology) (2020) *Recent Trends in AI-related Inventions – Report of July 2020*.

Kaempffert, W. (2020) Invention and Society, 1930, p. 30, quoted from Merges, R.P. 'Patent Markets and Innovation in the Era of Big Platform Companies', *Berkeley Technology Law Journal*, 35 (1), pp. 53–112.

Kim, K.G. (2016) 'Deep Learning', *HIR Health Informatics Research* 22 (4), pp. 351–354.

Kim, D. (2020) 'AI- Generated Inventions: Time to Get the Record Straight' *GRUR International*, 69(5), pp. 443–456.

Koay, N.Li-T. (2020) 'Artificial Intelligence and Inventorship: An Australian Perspective', JIPLP, 15, pp. 399–404.

Koza, J.R. (2010) 'Human-Competitive Results Produced by Genetic Programming', *Genetic Programming & Evolvable Machines*, 11, pp. 251–284.

Macleod, B.P. et al., *Self-Driving Laboratory for Accelerated Discovery of Thin-Film Materials*, <https://arxiv.org/ftp/arxiv/papers/1906/1906.05398.pdf> (last accessed 5 August 2020).

Marchant, J. (2020) 'Powerful antibiotics discovered using AI' *Nature News*, 20 February, <https://www.nature.com/articles/d41586-020-00018-3> (last accessed 5 August 2020).

Marrafia, M. and Paternoster, A. (2017) 'Models and Mechanisms in Cognitive Science', in: Magnani, L. and Bertolotti, T. (eds.), *Springer Handbook of Model Based Science*, Berlin: Springer.

Ménière, Y., and Pihlajamaa, H. (2019) 'Künstliche Intelligenz in der Praxis des EPA', *GRUR*, pp. 332–336.

Merriam-Webster (2020) *Artificial Intelligence*, <https://www.merriam-webster.com/dictionary/artificial%20intelligence≥ [https://www.perma.cc/24UH-MR3Z] (last accessed 5 August 2020).

McKinney, S.M. et al. (2020) 'Reply to: Transparency and Reproducibility in Artificial Intelligence', *Nature*, 586, p. E17.

Office of the Chief Economist IP Data Highlights (2020) *Adjusting to Alice – USPTO Patent Examination Outcomes after Alice Corp. v. CLS Bank International*, No. 3, April, p. 2.

Open Letter to the European Commission. Artificial Intelligence and Robotics, <http://www.robotics-openletter.eu> (last accessed 10 August 2020).

Patent Handbook, Annex B, Chapter 1, No. 1.2.1.2 Points to Note, <https://www.jpo.go.jp/e/system/laws/rule/guideline/patent/handbook_shinsa/document/index/app_b1_e.pdf> (last accessed 18 August 2020).

Proposal for a Directive of the European Parliament and of the Council on the patentability of computer-implemented inventions of 2002, (COM (2002) 92 final – 2002/0047 (COD)).

Ravid, Sh.Y., and Liu, X. (2018) 'When Artificial Intelligence Systems Produce Inventions: An Alternative Model for Patent Law at 3A Era', *Cardozo Law Rev*., 39, pp. 2215–2262;

Schulte, R., and Moufang, R. (2017) *Patentgesetz mit EPÜ*, 10th ed., Cologne: Carl Heymanns Publisher.

Schuster, W.M. (2018) 'Artificial Intelligence and Patent Ownership', *Wash. & Lee L. Rev*. 75, pp. 1945–2004;

Segler, M.H.S., Preuss, M., and Waller, M.P. (2018) 'Planning Chemical Synthesis With Deep Neural Networks and Symbolic AI', *Nature*, No. 555, p. 604.

Service, R.F. (2019) 'AIs Direct Search for Material Breakthroughs – Decision Making Algorithms Transform How Robots Evaluate and Synthesize Solar Cells and More', *Science*, 366, p. 1295.

Silver, D. et al. (2016) 'Mastering the Game of Go with Deep Neural Networks and Tree Search', *Nature*, 529, p. 484.

Silver, D. et al. (2019) 'A General Reinforcement Learning Algorithm Masters Chess, Shogi and Go Through Self-Play', *Science*, 362, pp. 1140–1144.

State Intellectual Property Office of People's Republic of China (SIPO), Ordinance No. 55 of January 2010.

Stergiou, C. and Siganos, D. (2014) *Neural Networks*, <http://srii.sou.edu.ge/neural-networks.pdf> (last accessed 5 August 2020).

Stokes, J.M. et al. (2020) '*A Deep Learning Approach to Antibiotic Discovery*', *Cell* 180, 20 February, pp. 689–690.

Straus, J. (2013) 'Ordre Public and Morality Issues in Patent Eligibility', in: Takenaka, T. (ed.), *Intellectual Property in Common Law and Civil Law*, Cheltenham (UK), Northampton (MA, USA): Edward Elgar Publisher, p. 19.

Straus, J. (2019) 'Issues Surrounding Deposit and Release of Biological Material for Patent Granting Procedures', *EIPR*, Issue 9, pp. 546–554.

Straus, J. (2021) 'Artificial Intelligence – Challenges and Chances for Europe', *European Review*, January, Vol. 29, No. 1, pp. 142–158.

Ullman, Sh. (2019) 'Using Neuroscience to Develop Artificial Intelligence', *Science*, 363, pp. 692–693.

US Patent and Trademark Office (2020) *Manual of Patent Examining Procedure (MPEP)*, Ninth Edition, Revision 10.2019, Last Revised June 2020, <https://www.uspto.gov/web/offices/pac/mpep/index.html> (last accessed 31 August 2020).

US Patent and Trademark Office (2020) *Public Views on Artificial Intelligence and Intellectual Property Policy*, Washington D.C. (USPTO Public Views), October.

US Patent and Trademark Office, *Artificial Intelligence*, <https://www.uspto.gov/initiatives/artificial-intelligence> (last accessed 24 November 2020).

US Patent and Trademark Office, Subject Matter Eligibility Examples: Abstract Ideas, <https://www.uspto.gov/sites/default/files/documents/101_examples_37to42_20190107.pdf> (last accessed 2 September 2020).

US Supreme Court, *Mackay Radio & Telegraph Co. v. Radio Corp. of Am.*, 306 U.S. 86, 94 (1939).

US Supreme Court, *Benson*, 409 U.S. 63, 71-72 (1972).

US Supreme Court, *Parker v. Flook*, 437 U.S. 584, 594 (1978).

US Supreme Court, *Diamond v. Chakrabarty,* 447 U.S. 303, 309 (1980).

US Supreme Court, *Diamond v. Diehr*, 450 U.S. 175, 191 (1981).

US Supreme Court, *Bilski v. Kappos*, 561 U.S. 593, 611 (2010).

US Supreme Court, *Bilski v. Kappos*, 561 U.S. 605 (2010).

US Supreme Court, *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66, 71 (2012).

US Supreme Court, *Alice Corp. Pty. Ltd. v. CLS Bank Int'l.*, 573 U.S. 208 (2014).

Wikipedia (2020) '*Evolutionary Algorithm*', <https://en.wikipedia.org/wiki/Evolutionary_algorithm> (last accessed 17 August 2020).

World Intellectual Property Organization (WIPO) (2019a) *Technology Trends 2019: Artificial Intelligence*.

World Intellectual Property Organization (WIPO) (2019b) *Conversation on Intellectual Property (IP) and Artificial Intelligence (AI)*, Doc. WIPO/IP/AI/2/GE/20/1.

Yang, St. *Amendments to the Guidelines for Patent Examination,* <https://www.lexology.com/library/detail.aspx?g=88cc460e-07d2-4d14-8e54-4f2c907ceec5> (last accessed 19 August 2020).