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The Global Artificial Intelligence Revolution Challenges Patent Eligibility Laws

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I. INTRODUCTION

A heart full of compassion, fortitude, sagacity, and hope distinguishes humans from machines.[1] The technology of artificial intelligence is now increasingly relied upon as a highly-proficient, human-assisting tool in a myriad of disciplines across the globe.

A prominent chef who collaborated with IBM's artificial intelligence "Chef Watson" was mesmerized by its culinary ingenuity.[2] When users input keywords, Chef Watson outputs a recipe by performing a comprehensive analysis of flavor combinations.[3] For example, in response to the keywords "tangerine," "punch," and "holiday," Chef Watson suggested a recipe for an aperitif named "Relax," which is a refreshing citrus cocktail with a slice of lemon and mint leaves on top.[4] When the user sought an appetizer with the keywords "crab," "soup," and "French-style," Chef Watson presented a recipe for a warm soup with a bundle of flat pasta made from elegantly-sliced radish.[5] The renowned human chef who cooked a full course meal from Chef Watson's recipes stated that the recipes had an element of surprise, and that the experience was enlightening.[6]

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1. *See* Thomas L. Friedman, Opinion, *From Hands to Heads to Hearts*, N.Y. TIMES (Jan. 4, 2017), https://www.nytimes.com/2017/01/04/opinion/from-hands-to-heads-to-hearts.html.

2. Norihiro Ikeda, *A Collaboration with a First-Class Chef: How Delicious Is Food Cooked by IBM's Watson? I Actually Tried It (1/2)*, ITMEDIA (Dec. 5, 2014), http://www.itmedia.co.jp/enterprise/articles/1412/05/news037.html [hereinafter Ikeda, *Food by Watson 1*].

3. *See id.*; *IBM Chef Watson: A Metaphor for Discovery*, IBM http://www-03.ibm.com/press/us/en/presskit/46500.wss (last visited Nov. 29, 2017); *see generally IBM Watson*, IBM http://www-03.ibm.com/press/us/en/presskit/27297.wss (last visited Nov. 29, 2017).

4. *See* Ikeda, *Food by Watson 1*, *supra* note 2.

5. *See id.*

6. Norihiro Ikeda, *A Collaboration with a First-Class Chef: How Delicious is Food Cooked by IBM's Watson? I Actually Tried It (2/2)*, ITMEDIA (Dec. 5, 2014), http://www.itmedia.co.jp/enterprise/articles/1412/05/news037_2.html.

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On August 13, 2017, *The Guardian* suggested that artificial intelligence can be a valuable resource for judges to render fair and consistent decisions.[7] In the medical sciences, pharmaceutical company GlaxoSmithKline announced a $43 million agreement enabling it to use British biotechnology company Exscientia's artificial intelligence technology for discovering life-saving medicine.[8] The artificial intelligence employed in this project will predict the behavior of molecules and indicate whether a medicine is likely to be beneficial, possibly reducing the cost and time of discovery by seventy-five percent.[9]

Artificial intelligence has already made concrete contributions.[10] Japan's National Institute of Information and Communications Technology uses artificial intelligence technology to foresee the magnitude and timing of solar flares.[11] The artificial intelligence system learned from 300,000 high-resolution photographs of the sun's surface.[12] By utilizing this artificial intelligence system, the Institute was able to enhance the accuracy of its predictions from fifty to eighty percent.[13]

Kewpie, a food manufacturing company in Japan, succeeded in doubling its productivity by using deep learning technology to select good quality potatoes.[14] Traditionally, employees visually inspected more than one million diced potatoes per day for quality assurance.[15] To streamline this time-consuming process, Kewpie used 18,000 pictures of diced potatoes to teach an artificial intelligence system what quality potatoes look like.[16] The system was thus trained to recognize high-quality potatoes automatically.[17]

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7.   John Naughton, *Why a Computer Could Help you Get a Fair Trial*, THE GUARDIAN (Aug. 13, 2017, 2:00 PM), https://www.theguardian.com/technology/commentisfree/2017/aug/13/why-a-computer-could-help-you-get-a-fair-trial.

8.   *See* Ben Hirschler, *Big Pharma Turns to AI to Speed Drug Discovery, GSK Signs Deal*, REUTERS (July 1, 2017, 8:10 PM), http://www.reuters.com/article/us-pharmaceuticals-ai-gsk-idUSKBN19N003.

9.   *See id.*

10.   *See, e.g.*, Kōtarō Fukuoka, *Solar Flare, A Prediction Accuracy of 80% with AI, Flare may Still Occur in the Next Seven Days*, NIHON KEIZAI SHINBUN (Sept. 8, 2017), https://www.nikkei.com/article/DGXLASDZ08H7H_Y7A900C1000000/.

11.   *See id.*

12.   *Id.*

13.   *Id.*

14.   Norihiro Ikeda, *The Productivity of Ingredients Inspection Doubles: Kewpie Starts Using AI - The Power of "Deep Learning" that Processes More Than 1 Million Potatoes A Day (2/2)*, ITMEDIA (June 20, 2017), http://www.itmedia.co.jp/enterprise/articles/1706/20/news049_2.html [hereinafter Ikeda, *Kewpie Starts Using AI 2*].

15.   Norihiro Ikeda, *The Productivity of Ingredients Inspection Doubles: Kewpie Starts Using AI - The Power of "Deep Learning" that Processes More Than 1 Million Potatoes A Day (1/2)*, ITMEDIA (June 20, 2017), http://www.itmedia.co.jp/enterprise/articles/1706/20/news049.html.

16.   *See* Ikeda, *Kewpie Starts Using AI 2*, *supra* note 14.

17.   *Id.*

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Artificial intelligence is also applied in the arts.[18] In August 2015, computer scientists in Tübingen, Germany, created an algorithm that enabled artificial intelligence to paint in the style of legendary artists.[19] The algorithm uses a "deep neural network" to make artificial intelligence learn the salient characteristics of Pablo Picasso's artistic style.[20] A "deep neural network" is a multiple-layered network of inter-connected processors modeled after neurons of the human brain.[21] When a user provides this artificial intelligence "maestro" with a scenic photograph of Tübingen, with its light pink, yellow, and sky-blue houses facing the Neckar River, the artificial intelligence produces a painting of this scenery that creates the impression that it was actually painted by Pablo Picasso.[22]

In December 2016, computer scientists in Paris, France, constructed an artificial intelligence that composes polyphonic chorales emanating the sublime style of Johann Sebastian Bach.[23] The scientists analyzed Bach's chorale music and represented the notes for the soprano, alto, tenor, and bass voices in numbers.[24] They also assigned numerical values for the beats and fermatas.[25] The researchers combined this data representation with an algorithm called Gibbs sampling and four neural networks to create a statistical model called DeepBach.[26] According to an experiment implementing DeepBach, approximately fifty percent of the 1,272 people who listened to DeepBach's music believed that it was genuinely composed by Johann Sebastian Bach.[27]

In these ways, artificial intelligence is starting to play a crucial role in assisting humans achieve various goals. Artificial intelligence has already brought concrete improvements to the operations of businesses.[28] It has also shown the capacity to enrich our culture and to add sprinkles of joy to our daily lives.[29] Research and innovation are indispensable for facilitating the contribution of artificial intelligence technology in our global society.

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18. Leon A. Gatys, Alexander S. Ecker & Matthias Bethge, *A Neural Algorithm of Artistic Style*, (Aug. 26, 2015), https://arxiv.org/pdf/1508.06576v2.pdf (last updated Sept. 2, 2015).

19. *Id.*

20. *Id.*

21. Jürgen Schmidhuber, *Deep Learning in Neural Networks: An Overview*, 61 NEURAL NETWORKS 85, 86 (2015); *Self-learning AI Emulates the Human Brain*, EUROPEAN RES. COUNCIL (July 22, 2016), https://erc.europa.eu/projects-and-results/erc-stories/self-learning-ai-emulates-human-brain.

22. Gatys et al., *supra* note 18, at 4–5.

23. GAËTAN HADJERES & FRANÇOIS PACHET, DEEPBACH: A STEERABLE MODEL FOR BACH CHORALES GENERATION 1 (Jun. 17, 2017), arxiv.org/pdf/1612.01010v2.pdf.

24. *Id.* at 4–5.

25. *Id.* at 4.

26. *Id.* at 1, 5–7.

27. *Id.* at 6–7.

28. *See supra* note 10–17 and accompanying text.

29. *See supra* note 18–27 and accompanying text.

Artificial Intelligence and Patent Eligibility

Do we have an effective legal system that supports the development of artificial intelligence? Patent law protects inventions.[30] It is designed to encourage innovation in our society.[31] It does so by providing inventors with a monopoly over their inventions for a limited time in exchange for properly disclosing their inventions to the public.[32] During the effective term of a patent for an invention, the patent allows the patent owner to preclude others from utilizing the invention without their authorization.[33]

There are a number of conditions that a patent applicant must fulfill to obtain a patent. For instance, the invention must be a subject matter that is eligible for patent protection.[34] This requirement is called the "patent eligibility" requirement.[35] Additionally, the invention must be novel[36] and non-obvious.[37] Patent applications must describe the invention with sufficient clarity and detail.[38] These are only some of the conditions that must be met for an invention to be protected by a patent.[39]

These conditions exist to balance the pros and cons of providing a monopoly under patent law.[40] A temporary monopoly over inventions provides inventors with a sense of relief, assuring that they have a legal right to prevent others from engaging in unauthorized use, imitation, and appropriation of their inventions.[41] On the other hand, this patent-based monopoly might hinder inventive activities if these activities require the use of rudimentary concepts or ingredients that are already protected by a patent.[42]

The patent eligibility requirement addresses these concerns.[43] This requirement ensures that the building blocks of innovation, such as abstract ideas and mental

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30.   Mark Harper, *U.S. Intellectual Property*, 95 Mich. B.J. 20, 20 (2016).

31.   Anna B. Laakmann, *An Explicit Policy Lever for Patent Scope*, 19 Mich. Telecomm. & Tech. L. Rev. 43, 44 (2012).

32.   Kenneth W. Dam, *The Economic Underpinnings of Patent Law*, 23 J. Legal Stud. 247, 248, 270–71 (1994).

33.   *See, e.g.*, *id.* at 247–248.

34.   *See, e.g.*, 35 U.S.C. § 101 (2012).

35.   Efthimios Parasidis, *A Uniform Framework for Patent Eligibility*, 85 Tul. L. Rev. 323, 326 (2010).

36.   35 U.S.C. § 102.

37.   *Id.* § 103.

38.   *See, e.g.*, *id.* § 112.

39.   *See, e.g.*, *id.* §§ 111–112.

40.   Dam, *supra* note 32, at 261.

41.   *Id.* at 248–49.

42.   *See id.* at 253 (explaining that broad patent protection can hinder future innovation).

43.   *See* Egenera, Inc. v. Cisco Sys., Inc., 234 F. Supp. 3d 331, 334 (D. Mass. 2017) (explaining that "[o]ne of the challenges for the patent system . . . is to separate out new and useful applications of abstract ideas from impermissible attempts to monopolize them").

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processes, are not bound by patents and remain available for use in technological progress.[44]

Some patent applications regarding artificial intelligence were rejected, and some existing patents covering artificial intelligence were invalidated due to the inventions' failure to satisfy the patent eligibility requirement.[45] Thus, patent eligibility is an important threshold that must be met to obtain patent protection in the area of artificial intelligence.[46]

Given the importance of the patent eligibility requirement and the growing prevalence of artificial intelligence in our global economy, this Article examines the patent eligibility jurisprudence of artificial intelligence under the laws of the United States of America, the European Patent Convention, France, Japan, and Singapore. By analyzing the judicial decisions of courts and the administrative judgments of patent offices relating to the patent eligibility of artificial intelligence, it is possible to illuminate the implicit *de facto* requirements that are imposed by these tribunals for artificial intelligence to be found patent-eligible.

These decisions and judgments indicate that an invention related to artificial intelligence is more likely to meet the patent eligibility requirement when the patent application specifies the inner workings of the invention in sufficient detail.[47] In addition, patent-eligible artificial intelligence often has a technical character.[48] Further, tribunals often expect patent applications to specify the technical effect achieved by the invention.[49]

Some features of artificial intelligence technology may be at odds with these requirements.[50] The jurisprudence of patent eligibility is flexible enough to allow room for creative judicial interpretations of broad statutory definitions.[51] This flexibility enables the patent eligibility jurisprudence to evolve in response to technical and societal changes associated with the rapid development of artificial intelligence.

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44.   *See* Parasidis, *supra* note 35, at 332.

45.   *See* Alice Corp. Pty. v. CLS Bank Int'l, 134 S. Ct. 2347, 2355–57 (2014); Decision of the European Patent Office, Technical Board of Appeal, Case T 22/85 – 3.5.1, Summary of Facts and Submissions ¶ VII (Oct. 5, 1988), http://www.epo.org/law-practice/case-law-appeals/pdf/t850022ep1.pdf.; Cour d'appel [CA] [regional court of appeal] Paris, 2e ch., Feb. 26, 2016, [15/01962] (Fr.).

46.   *See, e.g.*, *Alice Corp. Pty.*, 134 S. Ct. at 2355–57; Decision of the European Patent Office, Technical Board of Appeal, Case T 22/85 – 3.5.1, Summary of Facts and Submissions ¶ VII (Oct. 5, 1988), http://www.epo.org/law-practice/case-law-appeals/pdf/t850022ep1.pdf.; Cour d'appel [CA] [regional court of appeal] Paris, 2e ch., Feb. 26, 2016, [15/01962] (Fr.).

47.   *See infra* Parts III.A–III.E, IV.A.

48.   *See infra* Parts III.A–III.E, IV.B.

49.   *See infra* Parts III.A–III.E, IV.C.

50.   *See infra* Parts III.A–III.E, IV.A–IV.C, V.A–V.C.

51.   *See infra* Parts VI.A–VI.C.

ARTIFICIAL INTELLIGENCE AND PATENT ELIGIBILITY

Part II of this Article presents an overview of the technology of artificial intelligence. Part II.A discusses the definition and research areas of artificial intelligence. Part II.B describes a brief history of the development of artificial intelligence. Part II.C then explains how and why the global artificial intelligence revolution is taking place.

Part III presents a comparative case study concerning the patent eligibility of artificial intelligence. It explores the patent eligibility jurisprudence involving artificial intelligence technology under United States patent law, the European Patent Convention, the French Intellectual Property Code, Japanese patent law, and the Patents Act of Singapore.

Part IV analyzes the substantive requirements that surface from judicial decisions finding certain artificial intelligence technology to be patent-eligible. Although these requirements are not codified in patent statutes, case law suggests that they are *de facto* requirements for establishing the patent eligibility of artificial intelligence.

Part V analyzes the patent eligibility jurisprudence in light of the realities presently exhibited by artificial intelligence technology. It argues that artificial intelligence technology has certain features that create practical challenges when a patent applicant or owner is trying to establish patent eligibility before a court or an administrative tribunal.

Part VI ruminates on the future of the patent eligibility jurisprudence of artificial intelligence, examining the potential for legal systems to adapt to technological change.

II. ARTIFICIAL INTELLIGENCE TECHNOLOGY

A. Computers Performing Mental Steps

Artificial intelligence is defined as "the ability of machines to do things that people would say require intelligence."[52] The phrase sometimes refers to intelligent machines themselves.[53] Thus, artificial intelligence attempts to emulate the mental steps of human beings.[54] Such mental steps include understanding languages,[55] responding to questions,[56] identifying patterns,[57] solving problems,[58] and learning through experience.[59]

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52.   PHILIP C. JACKSON, JR., INTRODUCTION TO ARTIFICIAL INTELLIGENCE 1 (Dover Publ'n, Inc., 2d ed. 1985) (1974).

53.   *Id.* at 2.

54.   *See id.* at 8–9; *Self-Learning AI Emulates the Human Brain*, *supra* note 21.

55.   JACKSON, JR., *supra* note 52, at 292–93.

56.   *Id.* 312–330.

57.   *Id.* at 192–210.

58.   *Id.* at 75–108.

59.   *Id.* at 335–336.

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B. The Development of Artificial Intelligence Technology

The idea of making machines think and behave like humans has existed since antiquity.[60] In Greek mythology, the masterful Hephaestus built a gigantic robot that patrolled the island of Crete, monitoring whether laws were properly implemented.[61] Hephaestus even created intelligent tables that automatically supplied food and drinks.[62] During the Italian Renaissance, Leonardo da Vinci drew mechanical lions that moved autonomously.[63] One of them was designed to present a cluster of beautiful lilies.[64]

Professor George Boole's investigation on the "laws of thought,"[65] published in 1854, is respected as the "first step" towards the development of artificial intelligence software.[66] In 1943, Professors Warren McCulloch and Walter Pitts published "A Logical Calculus of the Ideas Immanent in Nervous Activity," establishing the cornerstone of neural networks.[67] Further, Mr. Alan Turing made a pioneering examination of the question, "Can machines think?" in his article titled "Computing Machinery and Intelligence," published in 1950.[68]

In 1955, Professor John McCarthy conceived the term "artificial intelligence."[69] In 1978, Professor Herbert A. Simon received the Nobel Prize in Economic Sciences for his "pioneering research into the decision-making process within economic

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60. *See* Association for the Advancement of Artificial Intelligence, *A Brief History of AI*, AITOPICS, https://aitopics.org/misc/brief-history (last visited Sept. 13, 2017); *see also Hephaestus and the Creation of the Robots*, GODS AND GODDESSES OF ANCIENT GREECE, http://www.greek-gods.info/greek-gods/hephaestus /myths/hephaestus-robots/ (last visited Sept. 13, 2017).

61. *See* Association for the Advancement of Artificial, *supra* note 60; *see also Hephaestus and the Creation of the Robots*, *supra* note 60; *see generally Hephaistos*, THEOI GREEK MYTHOLOGY, http://www.theoi.com/ Olympios/Hephaistos.html (last visited Sept. 13, 2017); *Talos*, THEOI GREEK MYTHOLOGY, http://www. theoi.com/Gigante/GiganteTalos.html (last visited Sept. 13, 2017).

62. *See Hephaestus and the Creation of the Robots*, *supra* note 60.

63. *See Pride of Da Vinci's Genius Walks Again After 500 years*, INDEPENDENT (July 3, 2009, 6:00 PM), http://www.independent.co.uk/arts-entertainment/art/features/pride-of-da-vincis-genius-walks-again-after-500-years-1731269.html.

64. *See* Jonathan Jones, *The Charisma Droids: Today's Robots and the Artists Who Foresaw Them*, THE GUARDIAN (Sept. 13, 2017), https://www.theguardian.com/artanddesign/2017/jan/28/charisma-droids-todays-robots-da-vinci-michelangelo-science-museum-robots.

65. *See generally* GEORGE BOOLE, AN INVESTIGATION OF THE LAWS OF THOUGHT, ON WHICH ARE FOUNDED THE MATHEMATICAL THEORIES OF LOGIC AND PROBABILITIES (1854).

66. *See* DOUGLAS R. HOFSTADTER, GÖDEL, ESCHER, BACH: AN ETERNAL GOLDEN BRAID 601 (Basic Books 1999).

67. *See generally* Warren S. McCulloch & Walter Pitts, *A Logical Calculus of Ideas Immanent in Nervous Activity*, 52 BULL. MATHEMATICAL BIOLOGY, no. 1, 1990, at 99–115; *see also* Association for the Advancement of Artificial Intelligence, *supra* note 60.

68. *See* HOFSTADTER, *supra* note 66, at 594–97.

69. *See generally* J. MCCARTHY, M. L. MINSKY, N. ROCHESTER & C.E. SHANNON, A PROPOSAL FOR THE DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE (Aug. 31, 1955); *see also* Association for the Advancement of Artificial Intelligence, *supra* note 60.

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organizations,"[70] theorizing "bounded rationality," a key concept in artificial intelligence.[71]

The 1990s saw "major advances" in all areas of artificial intelligence, including machine learning, reasoning, data mining, natural language understanding, vision, and virtual reality.[72] During this period, robots started excelling in playing chess at a world championship level, exploring Mars, and proving mathematical theorems.[73]

C. The Artificial Intelligence Revolution

The progress of artificial intelligence technology accelerated exponentially in the 2010s.[74] In December 2015, *Bloomberg* observed that "[c]omputers are smarter and learning faster than ever."[75] This phenomenal advancement is attributed to the reinforcement in cloud computing infrastructure, the growing availability of datasets and software development tools, and a significant reduction in the price of neural networks that are essential to machine learning.[76]

Artificial intelligence is becoming increasingly proficient in performing human tasks.[77] It is also becoming ubiquitous.[78] More and more enterprises are incorporating artificial intelligence into their operations.[79] This impacts a multitude of industries including law, healthcare, finance, engineering, customer service, entertainment, and communication.[80] In December 2016, *Bloomberg* remarked that "The Artificial

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70. Press Release, The Royal Swedish Academy of Sciences, *Studies of Decision-Making Lead to Prize in Economics* (Oct. 16, 1978), http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1978/press.html.

71. *See* Association for the Advancement of Artificial Intelligence, *supra* note 60.

72. *Id.*

73. *Id.*

74. *See* ERIK BRYNJOLFSSON & ANDREW MCAFEE, THE SECOND MACHINE AGE: WORK, PROGRESS, AND PROSPERITY IN A TIME OF BRILLIANT TECHNOLOGIES 20 (W.W. Norton & Co., 1st ed. 2014).

75. *See* Jack Clark, *Why 2015 Was a Breakthrough Year in Artificial Intelligence*, BLOOMBERG TECH. (Dec. 8, 2015, 8:00 AM), https://www.bloomberg.com/news/articles/2015-12-08/why-2015-was-a-breakthrough-year-in-artificial-intelligence.

76. *Id.*

77. *See, e.g.*, Gideon Lewis-Kraus, *The Great A.I. Awakening*, N.Y. TIMES (Dec. 14, 2016), https://www.nytimes.com/2016/12/14/magazine/the-great-ai-awakening.html.

78. *See infra* Part II.C.

79. *See* Jon Card, *A New Company Every Week: Inside the UK's AI Revolution*, THE GUARDIAN (May 15, 2017, 2:00 PM), https://www.theguardian.com/small-business-network/2017/may/15/artificial-intelligence-professor-stephen-hawking-sodash-crystal-xero.

80. *Id.*

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Intelligence Revolution Is Here."[81] *Fortune* named 2017 the "Year of Artificial Intelligence."[82]

III. COMPARATIVE CASE STUDY OF THE PATENT ELIGIBILITY OF ARTIFICIAL INTELLIGENCE

The patent eligibility of artificial intelligence has been scrutinized in a number of cases before judicial and administrative panels under the patent laws of the United States, the European Patent Convention, France, Japan, and Singapore.[83] Examining these cases elucidates substantive rules that are applied to determine the patent eligibility of artificial intelligence. This analysis also provides insights on the factual characteristics of cases in which the patent eligibility of artificial intelligence technology was upheld.

A. The United States of America

The jurisprudence of patent eligibility in the United States is based on section 101 of the United States Patent Act and a body of judicial decisions applying this statutory provision.[84] 35 U.S.C. § 101 provides that "[w]hoever 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 therefor, subject to the conditions and requirements of this title."[85]

Patents and patent applications contain "claims," which recite what the invention is.[86] These patent claims constitute a vital component of the patent because they delineate the boundaries of legal protection provided by that patent.[87]

Inventions in the area of artificial intelligence include methods for making computers implement mental steps[88] and devices that are designed to automatically

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81. *See The Artificial Intelligence Revolution Is Here,* BLOOMBERG (Dec. 2, 2016, 5:48 PM), https://www.bloomberg.com/news/videos/2016-12-02/the-artificial-intelligence-revolution-is-here.

82. *See* Adam Lashinsky, *2017 Will Be the Year of AI*, FORTUNE (Dec. 30, 2016), http://fortune.com/2016/12/30/the-year-of-artificial-intelligence/; *see also* Sandhya Venkatachalam, *Why 2017 Is The Year Of Artificial Intelligence*, FORBES (Feb. 27, 2017, 9:00 AM), https://www.forbes.com/sites/forbestechcouncil/2017/02/27/why-2017-is-the-year-of-artificial-intelligence.

83. *See infra* Parts IV.A–IV.E.

84. *See* UNITED STATES PATENT AND TRADEMARK OFFICE, PATENT ELIGIBLE SUBJECT MATTER: REPORT ON VIEWS AND RECOMMENDATIONS FROM THE PUBLIC 1 (July 2017), https://www.uspto.gov/sites/default/files/documents/101-Report_FINAL.pdf.

85. 35 U.S.C. § 101 (2012).

86. *See, e.g.*, UNITED STATES PATENT AND TRADEMARK OFFICE, MANUAL OF PATENT EXAMINING PROCEDURE 1800-30 (2015), https://www.uspto.gov/web/offices/pac/mpep/s1824.html.

87. *Id.*

88. *See* Larry Hauser, *Artificial Intelligence*, INTERNET ENCYCLOPEDIA OF PHILOSOPHY, http://www.iep.utm.edu/art-inte/ (last visited Sept. 15, 2017).

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carry out mental steps.[89] Section 101 does not state whether methods and devices implementing mental steps are eligible for patent protection.[90] The Supreme Court of the United States has held that mental processes, abstract intellectual concepts, and natural phenomena cannot be protected by a patent.[91]

Courts in the United States evaluate the patent eligibility of computerized implementations of mental processes and human activities in two steps.[92] The first step is determining whether the invention is directed to an "abstract idea."[93] The Federal Circuit has explained that courts have treated "analyzing information by steps people go through in their minds, or by mathematical algorithms, without more, as essentially mental processes within the abstract-idea category."[94] If the court determines that an invention is not directed to an abstract idea, the invention is patent-eligible.[95] Conversely, if the court decides that the invention is directed to an abstract idea, the court proceeds to the second step of the inquiry.[96]

The second step is determining whether the invention is "inventive."[97] In the patent eligibility inquiry, an invention is "inventive" when the patent claim at issue recites a feature of the invention that makes a contribution and thereby transforms an abstract idea into a patent eligible invention.[98] If the court determines that inventiveness is present, the invention will be patent-eligible.[99]

The Supreme Court has not defined what an "abstract idea" is.[100] Thus, courts in the United States determine whether a patent claim at issue is directed to an abstract idea by comparing the claim with those that were found to be directed to abstract ideas in previous cases.[101] Hence, examining court decisions on patent eligibility is vital to understanding the range of artificial intelligence inventions that are likely to be regarded as patent-eligible.

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89.   *See infra* Part III.A (analyzing judicial opinions concerning inventions that mitigate risk, adjust computer graphics, predefine structures of databases, and monitor data).

90.   35 U.S.C. § 101 (2012).

91.   *See* Gottschalk v. Benson, 409 U.S. 63, 67 (1972).

92.   *See* Alice Corp. Pty. v. CLS Bank Int'l., 134 S. Ct. 2347, 2355 (2014).

93.   *Id.*

94.   *See* Elec. Power Grp. v. Alstom S.A., 830 F.3d 1350, 1354 (Fed. Cir. 2016).

95.   *See Alice Corp. Pty.*, 134 S. Ct. at 2354.

96.   *Id.* at 2355.

97.   *Id.*

98.   *See* Mayo Collaborative Servs. v. Prometheus Labs., 566 U.S. 66, 77 (2012) ("The question before us is whether the claims do significantly more than simply describe these natural relations. To put the matter more precisely, do the patent claims add enough to their statements of the correlations to allow the processes they describe to qualify as patent-eligible processes that apply natural laws?").

99.   *Id.* at 72.

100.   *See* Enfish, LLC v. Microsoft Corp., 822 F.3d 1327, 1334 (Fed. Cir. 2016).

101.   *Id.*

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1. Computerized Mitigation of Financial Risk

In *Alice Corporation Pty. Ltd. v. CLS Bank International*, the invention at issue was a computerized method for mitigating settlement risk.[102] A settlement risk is the risk that a party in a financial transaction fails to pay the amount that it is obligated to pay.[103] To alleviate this risk, the invention used a computer as an intermediary to keep track of each party's account balance.[104] This ensured that the parties would have enough funds to carry out the financial transaction.[105]

The Supreme Court first determined that the invention in *Alice* was directed to an abstract idea of intermediated settlement.[106] The Court stated that intermediated settlement is "a fundamental economic practice long prevalent in our system of commerce."[107]

Next, the Court decided that the computerized method failed to transform the abstract idea into a patent-eligible invention because the method "merely require[d] generic computer implementation."[108] The Court pointed out that the computer performed a "purely conventional" process in each of the steps contained in the claimed method.[109] Moreover, the Court characterized "the use of a computer to obtain data, adjust account balances, and issue automated instructions" as a well-understood, routine, and conventional activity that is already known in the industry.[110] The Court noted that the computerized method did not "purport to improve the functioning of the computer itself," and did not make "an improvement in any other technology or technical field."[111] The Supreme Court therefore determined that the computerized method at issue in *Alice* was not patent-eligible.[112]

2. Automated Computer Graphics

A method for automatically adjusting computer graphics was determined to be patent-eligible in *McRO, Inc. v. Bandai Namco Games America Inc.*[113] The patent at issue recited a method for automatically animating lip synchronization and facial expressions of characters in computer graphics animation.[114]

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102.   *Alice Corp. Pty.*, 134 S. Ct. at 2352.

103.   *Id.* at 2351–52.

104.   *Id.* at 2352.

105.   *Id.* at 2351–53.

106.   *Id.* at 2355.

107.   *Id.* at 2356 (quoting Bilski v. Kappos, 561 U.S. 593, 611 (2010)).

108.   Alice Corp. Pty. v. CLS Bank Int'l., 134 S. Ct. 2347, 2357 (2014).

109.   *Id.* at 2358.

110.   *Id.* at 2359.

111.   *Id.*

112.   *Id.* at 2359–60.

113.   *See* McRO, Inc. v. Bandai Namco Games Am. Inc., 837 F.3d 1299, 1303 (Fed. Cir. 2016).

114.   *Id.*

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Computer graphics characters can smile, sing, and be flabbergasted because certain points on the characters' faces move to other positions at appropriate times.[115] Animators generally consult a timed transcript to determine when various points on a character's face should be transposed from one timeframe to another.[116] While looking at the animation screen, animators manually adjust the movement until they believe the displacement is correct.[117]

This displacement is expressed by a vector from a point in the "neutral model" to a corresponding point in the "morph target."[118] The "neutral model" represents the state of the character's face before the facial movement.[119] The "morph target" represents the state of the character's face after the facial movement.[120] A value called the "morph weight" is then assigned to a collection of these vectors for the entire face.[121]

The invention at issue in *McRO, Inc.* was a method for automating the process of accurately adjusting this displacement.[122] The Federal Circuit determined that this method was patent-eligible because it was not directed to an abstract idea.[123]

The Federal Circuit highlighted the specificity of the automation method recited in the patent claims at issue.[124] The claimed method embodied rules having specific characteristics.[125] The patented invention required these rules to be applied in a particular manner.[126] The Federal Circuit observed that these rules were not overly broad, but were appropriately limited because they defined the set of morph weights as a function of the timing of the sequence of sounds uttered by the computer graphics character.[127] Thus, the Federal Circuit observed that the automation method applied a series of concrete rules that transformed information into a certain format that was used to animate the characters.[128]

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115.   *See id.* at 1303–06.

116.   *See id.*

117.   *Id.*

118.   *Id.* at 1303.

119.   *See* McRO, Inc. v. Bandai Namco Games Am. Inc., 837 F.3d 1299, 1303 (Fed. Cir. 2016).

120.   *See id.*

121.   *Id.* at 1303–04.

122.   *See id.* at 1307. The specification for one of the patents at issue, United States Patent No. 6,307,576, describes that the invention's objective is to "provide a method for automatically . . . producing accurate and realistic lip synchronization and facial expressions in animated characters." *Id.*

123.   *Id.* at 1316.

124.   McRO, Inc. v. Bandai Namco Games Am. Inc., 837 F.3d 1299, 1313 (Fed. Cir. 2016).

125.   *Id.*

126.   *Id.* at 1315.

127.   *See id.* at 1313.

128.   *Id.* at 1315 (Fed. Cir. 2016).

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The Federal Circuit also emphasized that the "specific implementation"[129] of these concrete rules led to a technical improvement over conventional computer animation technology for two reasons.[130] First, the implementation was not the type of conventional methodology that an animator would have used.[131] Second, even though the invention used a computer to automate the animation process, the use of a computer alone, without the concrete rules recited in the patent claims, would not have generated the effects achieved by the invention.[132] Thus, the Federal Circuit determined that the automation method in *McRO, Inc.* was patent-eligible.[133] The *McRO, Inc.* case demonstrates that, as pointed out by the Federal Circuit, "[p]rocesses that automate tasks that humans are capable of performing are patent-eligible if properly claimed."[134]

3. Self-Referencing Database

In *Enfish, LLC v. Microsoft Corporation*, an invention concerning a self-referencing database was held to be patent-eligible.[135] Normally, computer programmers predefine the structures of databases.[136] The invention in *Enfish, LLC* enabled a database to reference itself so that programmers would not need to configure it.[137]

The United States District Court for the Central District of California determined that the invention was not patent-eligible because it was directed to the abstract idea of "storing, organizing, and retrieving memory in a logical table."[138]

On appeal, the Federal Circuit stated that the District Court's decision oversimplified the invention and downplayed its benefits.[139] The Federal Circuit found that the invention focused on a "specific asserted improvement in computer capabilities,"[140] and was directed to a "specific implementation of a solution to a problem in the software arts."[141]

The invention contributed to elevating conventional technology because it: (1) provided an indexing technique that increased the speed of searching data; (2) made the storing of images and unstructured text more efficient; and (3) augmented the

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129.   *Id.* at 1316.
130.   McRO, Inc. v. Bandai Namco Games Am. Inc., 837 F.3d 1299, 1316 (Fed. Cir. 2016).
131.   *Id.*
132.   *Id.* at 1313, 1315.
133.   *Id.* at 1316.
134.   *Id.* at 1313.
135.   Enfish, LLC v. Microsoft Corp., 822 F.3d 1327, 1329 (Fed. Cir. 2016).
136.   *Id.* at 1337.
137.   *Id.*
138.   *Id.*
139.   *Id.* at 1337–38.
140.   *Id.* at 1335–36.
141.   Enfish, LLC v. Microsoft Corp., 822 F.3d 1327, 1339 (Fed. Cir. 2016).

flexibility of the database's configuration.[142] The patent claims specifically set forth how the self-referential table contributed to these three benefits.[143] Therefore, the invention was determined to be patent-eligible.[144]

4. Wearable Technology

In *Fitbit Inc. v. AliphCom*,[145] the patent eligibility of wearable technology was at issue. Fitbit owns patents that protect inventions related to wearable devices.[146] Fitbit alleged that the defendants' activity-tracking devices infringed Fitbit's patents.[147] In response, the defendants asserted that Fitbit's patents were invalid for failing to satisfy the patent eligibility requirement.[148]

The United States District Court for the Northern District of California invalidated two of Fitbit's patents.[149] The District Court found that the patents did not claim a patent-eligible subject matter because they focused on simple data collection, which is an abstract idea.[150]

However, the District Court determined that the "Biometric Monitoring Device with Heart Rate Measurement Activated by a Single User-Gesture," claimed in Fitbit's U.S. Patent No. 9,042,971, might be patent-eligible because it focused on a specific improvement of data collection.[151] When a user made a gesture such as moving or staring at the device, a biometric sensor or a button activated the collection of data concerning the user's heart rate.[152] The data collection continued automatically until the level of heartbeat reached a predetermined quality.[153]

The District Court found that these characteristics pushed the invention beyond the realm of abstract ideas because the characteristics were tied to "an improvement to heart rate monitors as a technological tool, which [overcame] the problem of bulky user interfaces and provide[d] a way to more easily and efficiently gather a selective heart rate reading."[154]

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142.   *Id.*
143.   *See id.* at 1336.
144.   *Id.* at 1339.
145.   Fitbit Inc. v. AliphCom, No. 16-cv-00118-BLF (N.D. Cal. Mar. 2, 2017).
146.   *Id.* at 1.
147.   *Id.* at 4.
148.   *Id.*
149.   *Id.* at 22.
150.   *Id.* at 10, 22.
151.   Fitbit Inc. v. AliphCom, No. 16-cv-00118-BLF, slip. op. at 3, 20 (N.D. Cal. Mar. 2, 2017).
152.   *Id.* at 3.
153.   *Id.*
154.   *Id.* at 20.

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5. Analysis of Case Law in the United States

These cases illustrate the importance of specificity and technical contribution in establishing patent eligibility of artificial intelligence under United States law.[155] Where courts in the United States have found that an invention in the area of artificial intelligence meets the requirement for patent eligibility, the courts have pointed out how the patents at issue specifically described the invention's technical contribution.[156]

The driving force behind this emphasis on specificity and technical improvement is to prevent preemption.[157] When an inventor obtains a patent for a fundamental mental step, the patentee will have a monopoly over it throughout the effective term of the patent.[158] During this period, others are deprived of the unfettered use of this mental step because the patentee might file a patent infringement lawsuit against those who use the mental step without the patentee's authorization.[159] This impedes innovation and industrial application.[160]

Courts in the United States have expressly cautioned against this detrimental outcome.[161] The Supreme Court has stated that "[l]aws of nature, natural phenomena, and abstract ideas" are "the basic tools of scientific and technological work," adding that the "monopolization of those tools through the grant of a patent might tend to impede innovation more than it would tend to promote it."[162] The Federal Circuit

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155.   *See* Alice Corp. Pty. v. CLS Bank Int'l, 134 S. Ct. 2347, 2354 (2014) (citing Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2116 (2013)); McRO, Inc. v. Bandai Namco Games Am. Inc., 837 F.3d 1299, 1313 (Fed. Cir. 2016); Enfish, LLC v. Microsoft Corp., 822 F.3d 1327, 1336 (Fed. Cir. 2016); Fitbit Inc. v. AliphCom, No. 16-cv-00118-BLF, slip. op. at 10 (N.D. Cal. Mar. 2, 2017)).

156.   *Compare McRO, Inc.*, 837 F.3d at 1316, *and Enfish, LLC*, 822 F.3d at 1337–38, 1346, *with Fitbit Inc*., slip. op. at 14–15, 22.

157.   *McRO, Inc.*, 837 F.3d at 1313–14.

158.   Edison Elec. Light Co. v. Sawyer-Man Elec. Co., 53 F. 592, 598 (2d Cir. 1892); s*ee also* JOHN GLADSTONE MILLS III ET AL., PATENT LAW FUNDAMENTALS § 1.6 (2d ed. 2017).

159.   *See* Richard Stallman & Simon Garfinkle, *Viewpoint: Against Software Patents*, COMM. ACM, Jan. 1992, at 17; *see also* MILLS III ET AL., *supra* note 158, at §1.6; *but see* Martin Campbell-Kelly, *Not All Bad: An Historical Perspective on Software Patents*, 11 MICH. TELECOMM. TECH. L. REV. 191, 192–93 (2005).

160.   *See* Benjamin K. Sovacool, *Placing a Glove on the Invisible Hand: How Intellectual Property Rights May Impede Innovation in Energy Research and Development (R&D)*, 18 ALB. L.J. SCI. & TECH. 381, 414 (2008).

161.   Alice Corp. Pty. v. CLS Bank Int'l., 134 S. Ct. 2347, 2354 (2014) ("'[M]onopolization of those tools through the grant of a patent might tend to impede innovation more than it would tend to promote it,' thereby thwarting the primary object of the patent laws.") (quoting Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289, 1293 (2012)); *see also* U.S. CONST., art. I, § 8, cl. 8.

162.   *Alice Corp. Pty.*, 134 S. Ct. at 2354 (citing Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2116 (2013); Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289, 1293 (2012)); *see also* U.S. CONST., art. I, § 8, cl. 8.

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explained that "[t]he concern underlying the exceptions to [35 U.S.C.] § 101 is not tangibility, but preemption."[163]

Innovation in artificial intelligence is incremental.[164] Groundbreaking artificial intelligence technology builds upon existing technology.[165] Courts' rejection of patents concerning the fundamental tools of scientific development ensures that the "building blocks" of science will be available for developers to innovate artificial intelligence technology.[166]

B. The European Patent Convention

The European Patent Convention established a "centrali[z]ed, fundamentally autonomous and uniform procedure" for obtaining a European patent.[167] Article 52 of the European Patent Convention pertains to subject matter that is eligible for patent protection.[168]

Article 52(1) provides that "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."[169] According to Article 52(2), "(a) discoveries, scientific theories and mathematical methods; (b) aesthetic creations; (c) schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers; [and] (d) presentations of information" fall within the meaning of Article 52(1).[170] Article 52(3) provides that Article 52(2) "shall exclude the patentability of the subject-matter or activities referred to therein only to the extent to which a European patent application or European patent relates to such subject-matter or activities as such."[171]

Thus, if a European patent application or patent claims subject matter concerning artificial intelligence and a tribunal determines that the application or patent relates to "rules and methods for performing mental acts" *per se*, the subject matter will not

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163.   McRO, Inc. v. Bandai Namco Games Am. Inc., 837 F.3d 1299, 1315 (Fed. Cir. 2016) (citing *Mayo*, 132 S. Ct. at 1301 (2012)).

164.   *See* BRYNJOLFSSON & MCAFEE, *supra* note 74, at 1, 3–5.

165.   *See id.*

166.   *See generally* Alice Corp. Pty. v. CLS Bank Int'l., 134 S. Ct. 2347, 2354–55 (2014) (explaining the pre-emption principle and its role in balancing competing interests of denying patents to allow development against protecting novel methods by granting patents).

167.   EUROPEAN PATENT OFFICE, NATIONAL LAW RELATING TO THE EPC 3 (17th ed. 2015).

168.   EUROPEAN PATENT OFFICE, CONVENTION ON THE GRANT OF EUROPEAN PATENTS 108 (16th ed. June 2016), http://documents.epo.org/projects/babylon/eponet.nsf/0/9AB175036F5487D0C12581AA004AF054/$File/EPC_16th_edition_2016_en.pdf (compiling the European Patent Convention articles) [hereinafter EUROPEAN PATENT CONVENTION].

169.   *Id.*

170.   *Id.*

171.   *Id.*

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qualify as a patentable "invention" under Article 52.[172] It will therefore not be protected by a European patent.[173]

1. Automatically Abstracting Documents

The European Patent Office's Technical Board of Appeal (the "Board") determined that a system for automatically summarizing documents are excluded from patentable subject matter under Article 52.[174] The system was deemed to be directed to "rules and methods for performing mental acts" *per se*.[175]

The Board observed that the inventive aspect of the patent claim at issue was a set of innovative rules enabling the system to automatically summarize documents.[176] The Board, however, determined that merely reciting the steps for implementing these rules while using conventional computers "does not import any technical considerations" to the claimed subject matter.[177] According to the Board, the claimed system for automatically summarizing documents only contributed to "rules and methods for performing mental acts," which are expressly excluded from patentability under Article 52(2)(c).[178]

The applicant argued that the claimed system solved a technical problem because the system's automating features eliminated the burden of processing voluminous data.[179] However, the Board found that "the true problem to be solved was that of establishing a set of rules for document abstracting and retrieval on the basis of textual properties of the documents to be handled[,] which problem cannot be qualified as technical."[180] As a result, the system for automatically summarizing documents was found ineligible for patent protection under the European Patent Convention.[181]

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172.   *See id.*

173.   *See id.* (reasoning that if a claim does not fall within the definition of an "invention" under Article 51(1), it is ineligible for a patent under the European Patent Convention).

174.   *See* Decision of the European Patent Office, Technical Board of Appeal, Case T 22/85 – 3.5.1, Reasons for the Decision ¶ 5 (Oct. 5, 1988), http://www.epo.org/law-practice/case-law-appeals/pdf/t850022ep1.pdf.

175.   *Id.* Reasons for the Decision ¶ 5.

176.   *Id.* Reasons for the Decision ¶¶ 6–7.

177.   *Id.* Reasons for the Decision ¶ 8.

178.   *Id.* Reasons for the Decision ¶¶ 5, 9.

179.   *Id.* Reasons for the Decision ¶ 12.

180.   Decision of the European Patent Office, Technical Board of Appeal, Case T 22/85 – 3.5.1, Reasons for the Decision ¶ 12 (Oct. 5, 1988), http://www.epo.org/law-practice/case-law-appeals/pdf/t850022ep1.pdf.

181.   *Id.* Reasons for the Decision ¶ 15.

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2. Smart Server Summarizing Electronic Documents

The Board determined that a server that automatically summarized electronic documents exhibited a technical aspect.[182] The Board noted that the invention overcame multiple problems with smart servers including slow mobile data connections, limited processing capacities, and a deficiency in the display of mobile devices.[183] Once a mobile device requested a summary of an electronic document, the smart server automatically summarized the document and transmitted the summary to the mobile device.[184] The Board noted that the method performed by the smart server "appear[ed] in a technical context."[185] By using network servers, the method was carried out through technical means.[186]

3. Designing Three-Dimensional Receptacles

On January 20, 1995, the Board determined that a method and an apparatus for designing a three-dimensional receptacle were patentable "inventions" under Article 52.[187] The Board observed that the patent claim recited both excluded and non-excluded subject matter.[188] The "input unit for inputting data" involved "performing mental acts," which are excluded from patentability under Article 52(2)(c).[189] At the same time, the input, processing, output, and display units were components of computer hardware, which were not excluded from patentability.[190]

The Board has held that a conglomeration of excluded and non-excluded subject matters would be patentable if the conglomeration makes a technical contribution to "a field outside the field of excluded matters."[191] Applying this precedent, the Board concluded that the claimed subject matter made a technical contribution to "conventional computer art" for two reasons.[192]

First, the claimed apparatus designed a three-dimensional receptacle, which is a physical object.[193] Since the Board's decision in Case T 208/84 held that the presence

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182.   Decision of the European Patent Office, Technical Board of Appeal, Case T 0483/11 – 3.5.01, Reasons for the Decision ¶ 2.6 (Oct. 13, 2015), http://www.epo.org/law-practice/case-law-appeals/pdf/t110483eu1.pdf.

183.   *Id.* Reasons for the Decision ¶ 1.1.

184.   *Id.* Reasons for the Decision ¶¶ 1.2–1.3.

185.   *Id.* Reasons for the Decision ¶ 2.6.

186.   *Id.*

187.   Decision of the European Patent Office, Technical Board of Appeal, Case T 0605/93 – 3.5.1, Reasons for the Decision ¶ 5.9 (Jan. 20, 1995), https://www.epo.org/law-practice/case-law-appeals/pdf/t930605eu1.pdf.

188.   *Id.* Reasons for the Decision ¶ 5.7.

189.   *Id.* Reasons for the Decision ¶ 5.3; *see also* EUROPEAN PATENT CONVENTION, *supra* note 168, at 108.

190.   Decision of the European Patent Office, Technical Board of Appeal, Case T 0605/93 – 3.5.1, Reasons for the Decision ¶ 5.2 (Jan. 20, 1995), https://www.epo.org/law-practice/case-law-appeals/pdf/t930605eu1.pdf.

191.   *Id.* Reasons for the Decision¶ 5.7.

192.   *Id.* Reasons for the Decision ¶ 5.8.

193.   *Id.* Reasons for the Decision ¶ 5.8.

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of a physical entity indicates a "technical nature susceptible of being patented," the Board in the instant case suggested that the three-dimensional receptacle could be equated with the subject matter that was found to be patentable in Case T 208/84.[194] Second, the Board found that the input units were unconventional because they were specifically structured to receive a certain type of data representing cross-sections.[195] For these reasons, the Board determined that the claimed subject matter was a patentable "invention" that contributed to developing the conventional art.[196]

4. Automatic Auctions

On April 21, 2004, the Board declined to follow the "contribution" approach.[197] The Board remarked that the European Patent Convention does not provide any basis for allowing tribunals to make comparisons between the claimed subject matter and the prior art to determine whether the subject matter qualifies as a patentable "invention."[198]

The subject matter at issue was a computerized apparatus and a method for automatically performing auctions.[199] The Board determined that the apparatus was a patentable "invention," not because of the presence of any technical contribution over prior art, but because the apparatus genuinely incorporated "clearly technical features such as a 'server computer,' 'client computers' and a 'network.'"[200] Likewise, the Board found that the automated auction method was not excluded from patentable subject matter because the method involved technical means.[201] The Board emphasized that a claimed subject matter may have a technical character if technical means were used to carry out non-technical activities.[202]

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194.   *Id.*; *see* Decision of the European Patent Office, Technical Board of Appeal, Case T 208/84, Reasons for the Decision ¶ 3, (July 15, 1986), https://www.epo.org/law-practice/case-law-appeals/pdf/t840208ep1.pdf.

195.   Decision of the European Patent Office, Technical Board of Appeal, Case T 0605/93 – 3.5.1, Reasons for the Decision ¶ 5.8 (Jan. 20, 1995), https://www.epo.org/law-practice/case-law-appeals/pdf/t930605eu1.pdf.

196.   *Id.* at Reasons for the Decision ¶¶ 5.8–5.9.

197.   Decision of the European Patent Office, Technical Board of Appeal, Case T 258/03 – 3.5.1, Reasons for the Decision ¶¶ 3.3, 4.3. (Apr. 21, 2004), https://www.epo.org/law-practice/case-law-appeals/ pdf/ t030258ep1.pdf.

198.   *Id.*

199.   *Id.* Summary of Facts and Submissions § V.

200.   *Id.* Reasons for the Decision ¶ 3.7.

201.   *Id.* Reasons for the Decision ¶¶ 4.1, 4.7.

202.   *Id.* Reasons for the Decision ¶ 4.4.

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C. France

The patent eligibility jurisprudence of France embodies the framework established by the European Patent Convention.[203] Article L611-10 of the French Intellectual Property Code sets forth what is patentable.[204]

Section 1 of Article L611-10 defines patentable inventions, in all technological areas, as new inventions which involve an inventive step and can be applied industrially.[205] Section 2 of Article L611-10 lists the subject matters that are not considered to be inventions under Section 1.[206] These excluded subject matters are as follows:

(a) discoveries, scientific theories, and mathematical methods;

(b) aesthetic creations;

(c) schemes, rules, and methods for performing mental acts, playing games, or conducting economic activities, as well as computer programs; and

(d) presentations of information.[207]

Section 3 of Article L611-10 provides that the only instances in which the subject matters listed in Section 2 are excluded from patentability are when a patent application or patent only relates to one of the listed subject matters *per se*.[208]

1. Software Contributing to Petroleum Discovery

On June 15, 1981, the Court of Appeal of Paris issued a landmark decision in *Prospection Électrique Schlumberger*, declaring that the use of computer software to carry out certain steps of a method did not constitute sufficient grounds to deny patentability.[209] In this case, Schlumberger sought a French patent for a method relating to the exploration of petroleum in geological environments.[210] The method contained six steps.[211] Some of the steps were carried out by a computer program.[212]

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203. *See* CODE DE LA PROPRIÉTÉ INTELLECTUELLE [C. PR. INT.] [INTELLECTUAL PROPERTY CODE] art. L611-10.1 (Fr.) (stating that "[i]nventions which are inventive and capable of industrial application are patentable in all technological fields"); *see also* EUROPEAN PATENT CONVENTION, *supra* note 168, at 108 (stating that "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").

204. CODE DE LA PROPRIÉTÉ INTELLECTUELLE [C. PR. INT.] [INTELLECTUAL PROP. CODE] art. L611-10 *et seq.* (Fr.).

205. *Id.* § 1.

206. *Id.* § 2.

207. *Id.*

208. *Id.* § 3.

209. Cour d'appel [CA] [regional court of appeals] Paris, 4th ch. June 15, 1981 (Fr.), https://www.legalis.net/jurisprudences/cour-dappel-de-paris-4eme-chambre-section-a-arret-du-15-juin-1981.

210. *Id.*

211. *Id.*

212. *Id.*

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France's National Institute of Intellectual Property rejected Schlumberger's patent application, stating that the invention was directed to a series of instructions for machine calculations.[213] Schlumberger appealed.[214]

The Court of Appeal of Paris reversed the Institute's decision.[215] The Court stated that Schlumberger's method demonstrated a technical character for three reasons.[216] First, its goal related to the industry of oil exploration.[217] Second, it applied a series of concrete steps.[218] Third, the method generated information concerning the physical characteristics of geological environments, which was useful in the industry.[219]

Moreover, the Court of Appeal determined that a method cannot be deprived of patentability for the sole reason that some of its steps are carried out by a computer program.[220] The Court cautioned that denying patentability in such instances would mean that important emerging inventions requiring the use of computer programs would be denied patent protection.[221] The Court emphasized that this would lead to "aberrant consequences" in practice.[222] It should be noted that the *Schlumberger* case was decided pursuant to France's patent law of January 2, 1968, which was in force before the enactment of the current form of Article L611-10.[223]

2. In re Sesame Active System

On February 26, 2016, the Court of Appeal of Paris applied Article L611-10 in the case of *Sesame Active System*.[224] The Court analyzed whether a system and a method for automatically optimizing the cost-effectiveness of the transportation of merchandise were patentable subject matters under Article L611-10 of the French Intellectual Property Code.[225]

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213. *Id.*

214. *Id.*

215. Cour d'appel [CA] [regional court of appeals] Paris, 4th ch. June 15, 1981 (Fr.) https://www.legalis.net/jurisprudences/cour-dappel-de-paris-4eme-chambre-section-a-arret-du-15-juin-1981.

216. *Id.*

217. *Id.*

218. *Id.*

219. *Id.*

220. *Id.*

221. Cour d'appel [CA] [regional court of appeals] Paris, 4th ch. June 15, 1981 (Fr.), https://www.legalis.net/jurisprudences/cour-dappel-de-paris-4eme-chambre-section-a-arret-du-15-juin-1981.

222. *Id.*

223. *Id.*; CODE DE LA PROPRIÉTÉ INTELLECTUELLE [C. PR. INT.] [INTELLECTUAL PROPERTY CODE] art. L611-10 (Fr.).

224. Cour d'appel [CA] [regional court of appeal] Paris, 2e ch., Feb. 26, 2016, [15/01962] (Fr.).

225. *See id.* Sur la dénaturation et l'erreur de droit alléguées ¶ 3.

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The reloading of vehicles has a significant impact on the profitability of transporting merchandise.[226] The patent application at issue presented a system and a method for optimizing the loading of vehicles for both the outbound route and the return route.[227] The Court of Appeal of Paris found that these subject matters did not have any technical characteristic because the problem solved by the invention was economic in nature.[228] The Court observed that the system and method categorized data into three sets, each representing the load, time, and space.[229] The system and method also grouped data into two subsets representing shippers and transporters.[230] The Court stated that these features were directed to the simple organization of information and did not present any technical features.[231] In addition, the Court found that the central unit recited in the patent application was not technical either since it merely compared data, which was a simple implementation of a mental step.[232]

Although the invention contributed to automating the optimization process,[233] the Court pointed out that automation is commonly used, especially in business.[234] Moreover, the Court noted that the patent application failed to set forth a specific configuration for a solution exhibiting a technical character.[235] For these reasons, the Court of Appeal of Paris concluded that the claimed system and method were directed to an economic method, which is excluded from patentability under Article L611-10 of the French Intellectual Property Code.[236] As a result, the automation system and method were determined ineligible for patent protection.[237]

3. In re Dassault Systèmes

Similarly, on December 16, 2016, the Court of Appeal of Paris invalidated a method claim for lack of patentability under Article L611-10 in the case of *Dassault Systèmes*.[238] The claim recited a method that dynamically selected categories and key words that would yield better results if entered as query terms in a search engine.[239]

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226.   *Id.* Sur la demande de brevet en cause ¶ 1.

227.   *Id.* ¶ 2.

228.   *Id.* ¶ 4.

229.   *Id.* ¶ 9.

230.   Cour d'appel [CA] [regional court of appeal] Paris, 2e ch., Feb. 26, 2016, [15/01962] (Fr.), Sur la demande de brevet en cause, ¶ 9.

231.   *Id.*

232.   *Id.*

233.   *Id.* ¶ 11.

234.   *Id.*

235.   *Id.*

236.   Cour d'appel [CA] [regional court of appeal] Paris, 2e ch., Feb. 26, 2016, [15/01962] (Fr.), Sur le rapport de recherches, ¶ 3.

237.   *Id.*

238.   Cour d'appel [CA] [regional court of appeal] Paris, 2e ch., Dec. 16, 2016, [14/06444] (Fr).

239.   *Id.*, Faits et procédure, ¶ 2.

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The Court of Appeal of Paris reasoned that categories and key words result from subjective mental steps and were not technical tools.[240] Thus, the Court determined that the elements of the claimed method were directed to a mental step devoid of any technical character.[241]

4. Analysis of Case Law Under the European Patent Convention and French Patent Law

The decisions rendered under the European Patent Convention and French patent law illustrate the importance of claimed subject matter to have a technical character in order to qualify as a patentable "invention." It is imperative that the patent application articulate how the artificial intelligence-related invention employs technical means to resolve a technical problem and generate a technical effect.[242]

This emphasis on technical character reflects the long-standing practice of the member states of the European Patent Convention to require that an invention have a technical effect in order to be worthy of patent protection.[243] The European Patent Office explains that it has been a "part of the European legal tradition since the early days of the patent system that patent protection should be reserved for technical creations."[244]

D. Japan

While the technical characteristics of an invention play a key role in demonstrating patent eligibility in the European jurisprudence, a central inquiry under Japanese law is whether the claimed subject matter applies laws of nature.[245] This is because Article 2, Section 1 of the Japanese Patent Act defines an "invention" as a high-level creation of technical ideas using laws of nature.[246]

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240.   *Id.*

241.   *Id.*

242.   Stanislas Roux-Vaillard, *France, in* THE INTELL. PROP. REV. 78, 82 (5th ed. 2016) ("In practice, products and processes that provide technical means for solving a technical problem are, as a general rule, patentable.").

243.   Decision of the European Patent Office, Technical Board of Appeal, Case T 22/85 – 3.5.1, Reasons for the Decision ¶ 3 (Oct. 5, 1988), http://www.epo.org/law-practice/case-law-appeals/pdf/t850022ep1.pdf.

244.   EUROPEAN PATENT OFFICE, PATENTS FOR SOFTWARE? EUROPEAN LAW AND PRACTICE 12 (2013), http://documents.epo.org/projects/babylon/eponet.nsf/0/a0be115260b5ff71c125746d004c51a5/$FILE/patents_for_software_en.pdf [hereinafter EUROPEAN PATENT OFFICE, PATENTS FOR SOFTWARE?].

245.   *Compare* EUROPEAN PATENT OFFICE, PATENTS FOR SOFTWARE?, *supra* note 244, *with* Tokkyohō [Patent Act], No. 109 of 2006, art. 2, ¶ 1 (Japan).

246.   Tokkyohō [Patent Act], No. 109 of 2006, art. 2, para. 1 (Japan). Article 29, Section 1 of the Japanese Patent Act provides that a person who has invented an invention capable of industrial application may obtain a patent for that invention if, before the filing of the patent application, the invention was, both within Japan and abroad, (1) not publicly known, (2) not publicly practiced, and (3) not made available for public use through publications or online transmission. *Id*.

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1. Computer-Based Dental Treatment System

On June 24, 2008, the Intellectual Property High Court of Japan interpreted the term "invention" in Article 2, Section 1 to mean something that is completed through the steps of: (1) establishing a particular technical problem; (2) employing technical means to solve the problem; and (3) confirming that the technical configuration actually produces an effect that contributes to achieving the goal.[247] The High Court stated that a mental step *per se* is not an "invention," and is therefore not patent-eligible.[248]

However, the High Court noted that if the essence of the claimed subject matter assists humans in carrying out mental steps, or provides technical means that replace mental steps performed by humans, neither the inclusion of mental steps in the subject matter nor the subject matter's linkage to mental steps necessarily disqualifies the subject matter from being an "invention" under Article 2, Section 1 of the Japanese Patent Act.[249]

The patent claim at issue recited a computer-based dental treatment system.[250] The system evaluated the required dental treatment and formulated an initial treatment plan.[251] The system also suggested various designs for dental prosthesis.[252] The High Court observed that this system helped dentists create the best dental treatment plan for patients and select the best material for dental prosthesis by resolving the overflow of information associated with the advancement of dental treatment.[253] The High Court found that this system provided technical means for assisting dental treatment and was not directed to mental steps *per se*.[254] Hence, the Court concluded that the computerized system was a "creation of technical thought using laws of nature" and was therefore an "invention" under Article 2, Section 1 of the Japanese Patent Act.[255]

2. Knowledge Database System

On September 24, 2014, the High Court decided that a knowledge database system related to artificial intelligence did not qualify as an "invention" under Article 2,

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247. Chiteki Zaisan Kōtō Saibansho [Intell. Prop. High Ct.], June 24, 2008, Hei 19 (Gyō ke) no. 10369, IP JUDGMENTS DATABASE 1, 25, http://www.ip.courts.go.jp/app/files/hanrei_en/068/000068.pdf (Japan).

248. *Id.*

249. *Id.*

250. *Id.* at 2.

251. *Id.*

252. *Id.*

253. Chiteki Zaisan Kōtō Saibansho [Intell. Prop. High Ct.], June 24, 2008, Hei 19 (Gyō ke) no. 10369, IP JUDGMENTS DATABASE 1, 34, http://www.ip.courts.go.jp/app/files/hanrei_en/068/000068.pdf (Japan).

254. *Id.* at 35.

255. *Id.*

Section 1.[256] The patent application at issue described that many artificial intelligence researchers study the complex ways in which humans process information with written words.[257] The application stated that an experiment for generating artificial intelligence using a programing language called PROLOG was conducted, but "had limits."[258]

The patent application claimed a method for structuring a knowledge database system that could express objects and attributes without relying on words.[259] The High Court determined that this method did not qualify as an "invention" because the patent application failed to specify the technical significance and effect that could be achieved by a database that did not rely on words.[260] Further, the application did not describe any technical problems that conventional databases were causing due to their reliance on words.[261] Thus, the High Court concluded that the claimed knowledge database and computing method were nothing more than abstract concepts or artificial rules concerning the construction of databases.[262] The High Court stated that, although the method used computers, only generic computations were performed.[263]

3. Analysis of Case Law in Japan

The jurisprudence of patent eligibility in Japan resembles the American jurisprudence in that a specific disclosure of the invention's configuration and improvements over conventional technology are elements that contribute to a judicial finding that a claimed subject matter is patent-eligible.[264] The Japanese jurisprudence is also reminiscent of the European jurisprudence in that the technical means

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256.   Chiteki Zaisan Kōtō Saibansho [Intell. Prop. High Ct.], Sept. 24, 2014, Hei 26 (Gyō ke) no. 10014, IP Judgments Database 1, 34, http://www.ip.courts.go.jp/app/files/hanrei_jp/514/084514_hanrei.pdf (Japan).

257.   *Id.* at 19.

258.   *See id.* at 22.

259.   *See id.* at 25, 29–30.

260.   *Id.* at 29.

261.   *Id.*

262.   Chiteki Zaisan Kōtō Saibansho [Intell. Prop. High Ct.], Sept. 24, 2014, Hei 26 (Gyō ke) no. 10014, IP Judgments Database 1, 34, http://www.ip.courts.go.jp/app/files/hanrei_jp/514/084514_hanrei.pdf (Japan).

263.   *Id.*

264.   *Compare* Chiteki Zaisan Kōtō Saibansho [Intell. Prop. High Ct.], Sept. 24, 2014, Hei 26 (Gyō ke) no. 10014, IP Judgments Database 1, 34, http://www.ip.courts.go.jp/app/files/hanrei_jp/514/084514_hanrei.pdf (Japan) (finding that a technical effect or improvement is necessary for patent eligibility), *with* Alice Corp. Pty. v. CLS Bank Int'l, 134 S. Ct. 2347, 2359 (2014) (finding that applications that present abstract concepts alone without showing technological improvements are not enough for patent eligibility and that petitioner's claims did not purport to improve the functioning of the computer itself).

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associated with the claimed subject matter constitute a vital component of the High Court's interpretation of what a patentable "invention" is.[265]

The High Court's decision highlights that when a system implements mental steps to assist humans, the system will not be precluded from being a patent-eligible "invention."[266] This emphasis on an invention's capacity to assist humans resonates with the increasing use of artificial intelligence as a tool to aid human activities.[267]

E. Singapore

Singapore's Patents Act provides that "a patentable invention is one that satisfies the following conditions: (a) the invention is new; (b) it involves an inventive step; and (c) it is capable of industrial application."[268] Section 8.23 of the Examination Guidelines, outlined by the Intellectual Property Office of Singapore, confirms that "[m]ethods that are considered mental acts or schemes are generally not inventions."[269]

According to Section 8.2, examiners assessing patent eligibility will identify the "inventive concept" claimed in the patent application.[270] Section 8.3 further states that examiners should "identify the actual contribution which is made by the claimed subject matter, having regard to the problem to be solved, how the claimed subject matter works, and what its advantages are."[271] This examination practice suggests that, as in the United States, Europe, and Japan, specific descriptions of the technical significance of artificial intelligence-related inventions are important for demonstrating the patent eligibility of artificial intelligence in Singapore.

Singapore's Intellectual Property Office has conferred patent eligibility to a number of artificial intelligence-related inventions. For instance, on May 4, 2016, the Intellectual Property Office determined that an invention for automatic

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265. *Compare* Chiteki Zaisan Kōtō Saibansho [Intellectual Prop. High Ct.], Sept. 24, 2014, Hei 26 (Gyō ke) no. 10014, IP JUDGMENTS DATABASE 1, 29, http://www.ip.courts.go.jp/app/files/hanrei_jp/514/084514_hanrei .pdf (Japan) (holding that failure to define the technical significance of the creation will not qualify it as an "invention"), *with* Decision of the European Patent Office, Technical Board of Appeal, Case T 0483/11 – 3.5.01, Reasons for the Decision ¶ 2.6 (Oct. 13, 2015), http://www.epo.org/law-practice/case-law-appeals/pdf/t110 483eu1.pdf (stating that the presence of a technical character in a claimed method is relevant to the issue of whether the method qualifies as an invention under Article 52(1) of the European Patent Convention).

266. *See* Chiteki Zaisan Kōtō Saibansho [Intell. Prop. High Ct.], June 24, 2008, Hei 19 (Gyō ke) no. 10369, IP JUDGMENTS DATABASE 1, 25, http://www.ip.courts.go.jp/app/files/hanrei_en/068/000068.pdf (Japan) (stating that an invention at issue "can be understood as providing a computer-based technical means for assisting dental treatment").

267. *See id.* at 35.

268. Singapore Patents Act, ch. 221, Art. 13(1) (2005).

269. INTELL. PROP. OFFICE OF SINGAPORE, EXAMINATION GUIDELINES FOR PATENT APPLICATIONS AT IPOS 260 (2017), http://www.wipo.int/edocs/lexdocs/laws/en/sg/sg069en.pdf.

270. *Id.* at 253.

271. *Id.* at 253–54.

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aggregation of financial data satisfied Singapore's patent eligibility requirement.[272] On February 3, 2017, the Intellectual Property Office granted a patent for an invention that automatically cultured biological cells.[273]

IV. IMPLICIT, DE FACTO REQUIREMENTS FOR PATENT-ELIGIBLE ARTIFICIAL INTELLIGENCE

The patent eligibility jurisprudence under the laws of the United States, the European Patent Convention, France, Japan, and Singapore indicates that there are implicit, *de facto* requirements for establishing the patent eligibility of artificial intelligence technology.[274]

A. Specific Portrayal of the Invention

First, tribunals require that artificial intelligence inventions be described with specificity.[275] Methods, systems, and apparatus that are designed to perform various mental steps of humans have been denied patent eligibility because the patents at issue did not articulate the problem that the invention was designed to solve, the specific configuration of the invention, and the invention's effect.[276]

B. Manifestation of Technical Characteristics

Second, patent-eligible artificial intelligence often exhibits a technical character.[277] The importance of having a technical character is salient in the European jurisprudence.[278] Generally speaking, decisions rendered by United States courts do not emphasize the significance of technical characteristics because the primary inquiry is whether the invention is directed to an abstract idea and whether it demonstrates inventiveness.[279] Yet, the automated computer graphics system in *McRO*, *Inc.*, the self-referencing database in *Enfish*, *LLC*, and the wearable technology in *Fitbit, Inc.,* all possessed technical characteristics that were found to meet the patent eligibility requirement.[280] This is true in Japan and Singapore as well.[281] A technical characteristic is a critical component of patent-eligible inventions

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272.   Singapore Patent No. 11201507409Q (issued May 4, 2016).

273.   Singapore Patent No. 11201405632P (issued Feb. 3, 2016).

274.   *See supra* Part III.

275.   *See supra* Part III.

276.   *See supra* Part III.

277.   *See supra* Parts III.A–III.E.

278.   *See supra* Part III.B.4.

279.   *See* Alice Corp. Pty. v. CLS Bank Int'l, 134 S. Ct. 2347, 2354 (2014).

280.   *See supra* Parts III.A.1, III.A.2, III.A.4.

281.   *See supra* Parts III.D–III.E.

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under Japanese law.[282] Singapore's Examination Guidelines illustrate that "various technical features" contribute to patent eligibility.[283]

C. Transcending Generic Computation

Third, tribunals have denied patent eligibility when artificial intelligence simply makes generic computers perform mental steps.[284] The Federal Circuit's decisions indicate that artificial intelligence inventions that concretely improve conventional technology are patent-eligible.[285] However, the European Patent Office's Technical Board of Appeal declined to follow this "contribution" approach.[286]

This difference may be explained by the recurring problem of patent assertion entities in the United States.[287] Dismissing meritless patent lawsuits early helps resolve this issue.[288] The likelihood that lawsuits will be dismissed early is greater when the threshold for establishing patent eligibility is higher.[289] The "contribution" approach elevates this threshold by effectively adding novelty and inventiveness evaluations to the patent eligibility inquiry.[290]

Meanwhile, the European Patent Convention provides a basis for the patent eligibility jurisprudence constructed through decisions of the European Patent Office.[291] Following the statutory structure of the European Patent Convention, the European Patent Office's Technical Board of Appeal separates the patent eligibility

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282. *See supra* Part II.D.

283. INTELL. PROP. OFFICE OF SINGAPORE, EXAMINATION GUIDELINES FOR PATENT APPLICATIONS AT IPOS 254–55 (2017), http://www.wipo.int/edocs/lexdocs/laws/en/sg/sg069en.pdf.

284. *See, e.g.*, Gottschalk v. Benson, 409 U.S. 63, 67 (1972) ("[M]ental processes, and abstract intellectual concepts are not patentable, as they are the basic tools of scientific and technological work.").

285. *See, e.g.*, Enfish, LLC v. Microsoft Corp., 822 F.3d 1327, 1333 (Fed. Cir. 2016) ("The patents teach that multiple benefits flow from this design. First, the patents disclose an indexing technique that allows for faster searching of data than would be possible with the relational model. . .the patents teach that the self-referential model allows for more effective storage of data other than structured text, such as images and unstructured text . . . the patents teach that the self-referential model allows more flexibility in configuring the database.").

286. *See generally* Decision of the European Patent Office, Technical Board of Appeal, T 258/03 – 3.5.1 (Apr. 21, 2004), https://www.epo.org/law-practice/case-law-appeals/pdf/t030258ep1.pdf.

287. For an overview on patent assertion entities, see FEDERAL TRADE COMMISSION, PATENT ASSERTION ENTITY ACTIVITY: AN FTC STUDY (2016), https://www.ftc.gov/reports/patent-assertion-entity-activity-ftc-study.

288. Circuit Judge Haldane Mayer, in a concurring opinion, has stated that the court's evaluation of patent eligibility "at the outset not only conserves scarce judicial resources and spares litigants the staggering costs associated with discovery and protracted claim construction litigation, it also works to stem the tide of vexatious suits brought by the owners of vague and overbroad business method patents." OIP Techs., Inc. v. Amazon.com, Inc., 788 F.3d 1359, 1364–5 (Fed. Cir. 2015) (Mayer, J., concurring).

289. *See id.*

290. *See* Mayo Collaborative Servs. v. Prometheus Labs., 566 U.S. 66, 73, 77 (2012).

291. *See supra* Part III.B (describing the patent eligibility jurisprudence under the European Patent Convention).

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inquiry under Article 52 of the European Patent Convention from the novelty and inventiveness inquiries under Articles 54 and 56.[292]

V. ARTIFICIAL INTELLIGENCE IMPOSES CHALLENGES TO ESTABLISHING PATENT ELIGIBILITY

The implicit, *de facto* requirements for patent eligibility may be at odds with the nature presently manifested by artificial intelligence technology.[293] This potential clash is disconcerting because if the patent eligibility jurisprudence imposes requirements that cannot realistically be met by artificial intelligence inventions due to the technology's inherent nature, these inventions will inevitably be foreclosed from patent protection.[294] Patent eligibility laws, in their current form, would not be able to confer their benefits to protect artificial intelligence technology.

A. The "Inexplicability Problem"

The mechanism of artificial intelligence is often inexplicable.[295] Even computer scientists who write computer programs for artificial intelligence systems sometimes have difficulty explaining why and how their computer programs made an artificial intelligence system behave in a certain way.[296] This reality conflicts with the *de facto* specificity requirement.[297]

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292.   *See* Decision of the European Patent Office, Technical Board of Appeal, Case T 258/03 – 3.5.1, Reasons for the Decision ¶¶ 3.1 (Apr. 21, 2004), https://www.epo.org/law-practice/case-law-appeals/pdf/t030258ep1.pdf ("The verification that [the] claimed subject-matter is an invention within the meaning of Article 52(1) EPC is in principle a prerequisite for the examination with respect to novelty, inventive step and industrial application since these latter requirements are defined only for inventions (cf[.] Articles 54(1), 56, and 57 EPC). The structure of the EPC therefore suggests that it should be possible to determine whether subject-matter is excluded under Article 52(2) EPC without any knowledge of the state of the art (including common general knowledge).").

293.   *See infra* Parts V.A–V.C.

294.   *See supra* Part III.

295.   Morgane Tual, *Au-delà des Fantasmes, Quels Sont les Problèmes Concrets que Pose L'intelligence Artificielle?*, LE MONDE.FR : PIXELS (Aug. 3, 2017), http://www.lemonde.fr/pixels/article/2017/08/03/au-dela-des-fantasmes-quels-sont-les-problemes-concrets-que-pose-l-intelligence-artificielle_5168330_4408996.html; Hubert Guillaud & Rémi Sussan, *L'intelligence Artificielle Va-t-elle Rester Impénétrable?* LE MONDE.FR: BLOGS, (Oct. 30, 2016), http://internetactu.blog.lemonde.fr/2016/10/30/lintelligence-artificielle-va-t-elle-rester-impenetrable. *See also* JACKSON, JR., *supra* note 52, at 396 (expressing this problem as the "lack of understanding" question, explaining that "the possibility exists that intelligent machines might be too complicated for us to understand in situations that require real-time analyses"); HOFSTADTER, *supra* note 66, at 679 ("[T]he 'pond' of an AI program will turn out to be so deep and murky that we won't be able to peer all the way to the bottom.").

296.   See Guillaud & Sussan, *supra* note 295 (pointing out that, even the creator of computer programs for artificial intelligence programs that operate by using data to discover rules will have difficulty explaining why and how the artificial intelligence works).

297.   *See id.*; *see infra* Parts V.A–V.C.

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Under the present patent eligibility jurisprudence, an invention is more likely to be deemed ineligible for patent protection if the configuration of the invention is not described with specificity.[298] However, the configuration of some artificial intelligence cannot be understood, let alone described with specificity.[299] Such artificial intelligence inventions are likely to be foreclosed from patent protection.

B. Omnipresence of Artificial Intelligence in Non-Technical Liberal Arts

Next, patent-eligible inventions often demonstrate a technical character.[300] Yet, artificial intelligence is used broadly in the liberal arts including economics, music, art, psychology, linguistics, and literature.[301] The European Patent Office's Technical Board of Appeal has pointed out that "an invention may have technical aspects which are hidden in a largely non-technical context."[302]

For example, even if artificial intelligence technology used in music employs technical means, a tribunal might find that the invention's "essence" is inexorably tied to music, a non-technical discipline, and is therefore non-technical in nature. This creates a problem because patent eligibility may ultimately be denied for lack of technical character.[303] This problem arguably originates from the practice of extracting the "essence" of an invention, rather than giving effect to every element recited in a patent claim.[304]

C. Transfiguration of Conventional Artificial Intelligence Technology

Artificial intelligence research may be heading in an opposite direction from the inclinations associated with patent eligibility. According to the present patent eligibility jurisprudence, courts are less likely to determine that conventional, general-purpose computers performing mental steps are patent-eligible.[305] This means that the more specialized the invention, the more likely it will be held patent-eligible, compared to inventions having generalized features.[306] In contrast, an artificial intelligence system that acts as a generalized problem solver, carrying out

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298.   *See supra* Parts II.A–II.E, III.A.

299.   *See supra* note 295–96 and accompanying text.

300.   *See supra* Part IV.B.

301.   *See generally* HADJERES & PACHET, *supra* note 23; Gatys et al., *supra* note 18.

302.   Decision of the European Patent Office, Technical Board of Appeal, Case T 0258/03 – 3.5.1, Reasons for the Decision ¶ 3.6 (Apr. 20, 2004), https://www.epo.org/law-practice/case-law-appeals/pdf/t030258ep1.pdf.

303.   Decision of the European Patent Office, Technical Board of Appeal, Case T 1883/09 – 3.2.04, Reasons for the Decision ¶¶ 2.3, 3.6, (Sep. 20, 2012), http://www.epo.org/law-practice/case-law-appeals/pdf/t091883 eu1.pdf.

304.   *See, e.g.*, *supra* Parts III.A.3, III.B.1, III.D.1, III.E.

305.   *See supra* Parts III.A–III.E, IV.C.

306.   *See supra* Parts III.A–III.E, IV.C.

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a vast array of cognitive functions, is regarded as more advanced than a specialized artificial intelligence system that is tailored to carry out a particular step.[307]

Another discrepancy between the directions of patent eligibility laws and artificial intelligence research relates to the concept of mental acts *per se*.[308] Under the current patent eligibility jurisprudence, an invention is more likely to be found patent-eligible if it is further distinguished from mental steps *per se*.[309]

Presently, this tendency is congruous with various artificial intelligence technologies because there is a dichotomy between artificial intelligence and the actual mental steps that take place in the human brain.[310] Artificial intelligence uses computational methods to reproduce the results of human mental activity.[311] Machines that achieve the end results of human cognition are different from devices that replicate every biological and cognitive process that occurs in the human brain to reach those results.[312] A quintessential example is an automatic translating machine.[313] It outputs a translation by using statistical analysis and numerical methods.[314] This is different from how humans translate languages.[315]

However, rather than distancing itself further and further from actual biological mental activities, artificial intelligence appears to be approaching mental steps *per se*. Professor Philip C. Jackson, Jr. explains that "introspection is probably the source most commonly used in artificial intelligence research for information about specific problem-solving abilities of human intelligence."[316] On July 27, 2017, computer scientists created a nanometric component modeled from a biological neuron, and used it instead of computers to create an artificial intelligence machine that could recognize vocal pronunciations with a success rate of 99.6%.[317] Similarly, researchers are trying to incorporate human emotions into the mechanisms of artificial intelligence as an alternative to relying solely on computational logic.[318] Researchers have also discovered that modeling biological evolution and simulating

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307.　　*See* JACKSON, JR., *supra* note 52, at 108.

308.　　*See infra* Part V.C.

309.　　*See supra* Parts III.A–III.E, IV.B.

310.　　*See infra* Part V.C.

311.　　*See supra* Part II.

312.　　*See infra* Part V.C.

313.　　*See* Brian Hayes, *The Manifest Destiny of Artificial Intelligence*, 100 AM. SCIENTIST 282, 285 (2012).

314.　　*See id.*

315.　　*See id.*

316.　　JACKSON, JR., *supra* note 52, at 8.

317.　　David Larousserie, *Des chercheurs dotent un ordinateur de neurones artificiels*, LEMONDE.FR. (Aug. 8, 2017), http://www.lemonde.fr/sciences/article/2017/08/08/des-chercheurs-dotent-un-ordinateur-de-neurones-artificiels_5170010_1650684.html.

318.　　Aaron Sloman, *What is Artificial Intelligence?*, SCH. OF COMPUT. SCI., UNIV. OF BIRMINGHAM, 2007, http://www.cs.bham.ac.uk/research/projects/cogaff/misc/aiforschools.html.

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the evolutionary process offer insights for solving problems.[319] These developments indicate that artificial intelligence research is evolving and expanding in a direction that approaches mental steps *per se*.

VI. LAW'S POTENTIAL TO ADAPT TO THE TECHNOLOGICAL PROGRESS OF ARTIFICIAL INTELLIGENCE

The progress of technology in general can be expressed as an exponential curve.[320] According to Professors Erik Brynjolfsson and Andrew McAfee, the world is currently at the stage where the exponential curve is becoming increasingly steep.[321] This stage is where "the numbers start to become so big they are inconceivable."[322] Moreover, these numbers "leave our intuition and experience behind."[323] Thus, how precisely artificial intelligence will develop and be used in society in the future is unknown.

The present patent eligibility jurisprudence under the laws of the United States, European Patent Convention, France, Japan, and Singapore is supple enough to adapt to future evolutions in artificial intelligence technology.[324] There are three reasons for this proposition.[325]

A. Common Law Reflecting Public Policy Arguments

First, the United States legal system embodies the tradition of common law, formed through the accumulation of judicial decisions.[326] Although the role of the judiciary is not to create law but to apply existing law, the inherent nature of common law allows room for policy arguments to be reflected in the way law is applied in the pursuit of justice and in light of the social needs that will surface due to the growing prevalence and advancement of artificial intelligence.[327]

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319.   *Id.*; *see also* L. Spector, *Evolution of artificial intelligence*, 170 ARTIFICIAL INTELLIGENCE 1251, 1252 (2006) (discussing the advancement of evolutionary algorithms).

320.   BRYNJOLFSSON & MCAFEE, *supra* note 74, at 4–6.

321.   *Id.* at 48.

322.   *Id.* at 46.

323.   *Id.* at 47.

324.   *See infra* Parts VI.A–VI.C.

325.   *See infra* Parts VI.A–VI.C.

326.   *See* Thomas Healy, *Stare Decisis as a Constitutional Requirement*, 104 W. VA. L. REV. 43, 44 (2001) (discussing the history and effectiveness of *stare decisis* in American jurisprudence).

327.   *See supra* Part III.A.

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B. Invigorating Undefined Statutory Terms in Civil Law

Second, the European Patent Convention does not define what an "invention" is.[328] This lack of definition confers flexibility to the jurisprudence of patent eligibility because tribunals will inevitably confront the issue of construing the term "invention."[329] The European legislature decided not to define the word "technology" either, ensuring that "adequate protection would be available for the results of developments in the future in fields of research which the legislator could not foresee."[330] The legislative records on the European Patent Convention state that "it will remain incumbent on EPO practice and case law to determine whether subject-matter claimed as an invention has a technical character and to further develop the concept of invention in an appropriate manner, in light of technical developments and the state of knowledge at the time."[331]

Similarly, the Japanese Patent Act provides a broad definition of "invention" and leaves the concrete application and interpretation of this definition to courts and academic commentary.[332] Therefore, the breadth of the interpretation of statutory language such as "invention" and "natural laws" is capable of evolving.

C. Judicial Versatility

Third, judicial evolution has already taken place in response to technological progress.[333] In October 1988, the European Patent Office's Technical Board of Appeal denied the patent eligibility of a system that automatically summarized documents.[334] The Board decided that this system did not have a technical character.[335] Approximately twenty-seven years later, the Board conferred patent eligibility to a similar invention.[336] The invention was a server that automatically

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328. EUROPEAN PATENT OFFICE, CASE LAW OF THE BOARD OF APPEAL OF THE EUROPEAN PATENT OFFICE 2 (8th ed. 2016) [hereinafter CASE LAW OF THE BOARD OF APPEAL OF THE EPO]; *see also* EUROPEAN PATENT CONVENTION, *supra* note 168, at 108.

329. *See* EUROPEAN PATENT CONVENTION, *supra* note 168, at 108.

330. Decision of the European Patent Office, Enlarged Board of Appeal, Case G 0002/07, Reasons for the Decision ¶ 6.4.2.1 (Dec. 9, 2010), http://www.epo.org/law-practice/case-law-appeals/pdf/g070002ex1.pdf.

331. EUROPEAN PATENT OFFICE, OFFICIAL JOURNAL OF THE EUROPEAN PATENT OFFICE 1, 48 (special ed. 4 2007), http://archive.epo.org/epo/pubs/oj007/08_07/special_edition_4_epc_2000_synoptic.pdf; s*ee also* Anton S. Holzwarth, *Patent Protection and Computer Programs in the Practice of the European Patent Office* 1, 3 (1998), http://www.wipo.int/mdocsarchives/WIPO_CNR_KYI_98/WIPO_CNR_KYI_98_3_E.pdf.

332. *See infra* Part III.D; *see also* NOBUHIRO NAKAYAMA, PATENT LAW 94 (3d ed. 2016) (translation by author).

333. *See infra* Part V.C.

334. Decision of the European Patent Office, Technical Board of Appeal, Case T 22/85 - 3.5.1 (Oct. 5, 1988), http://www.epo.org/law-practice/case-law-appeals/pdf/t850022ep1.pdf.

335. *Id.* Summary of Facts ¶ X.

336. Decision of the European Patent Office, Technical Board of Appeal, Case T 1286/10 -3.5.05 (Apr. 14, 2015), http://www.epo.org/law-practice/case-law-appeals/pdf/t101286eu1.pdf.

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summarized electronic documents.[337] This time, the Board found that the automatic summarizing invention had a technical character.[338] These two cases may illustrate a change in how the Board construes the concept of "technical character."[339]

Judicial progression has occurred in Japan as well.[340] The phrase "natural law" was previously interpreted narrowly to mean "the production of objects."[341] However, such a narrow interpretation is no longer supported by Japanese courts.[342] Moreover, with the prevalence of computer programs, the Japanese Patent Office repeatedly revised its examination guidelines to allow more flexibility in the interpretation of the definition of the term "invention," ensuring that the threshold of patent eligibility will be met by a variety of software-related applications.[343]

The adaptability of patent eligibility laws demonstrated in response to the development of servers and software strongly suggests that, similar to common law in the United States, the jurisprudence under the civil law systems of Europe and Japan is equally capable of adapting to the progress of artificial intelligence.[344] The same is true of Singapore's Patents Act because Article 13(1) uses broad terminology to define the phrase "patentable invention."[345] It should be kept in mind that judicial versatility must originate from the statute.[346] As former Chief Judge Randall Rader of the United States Court of Appeals for the Federal Circuit perspicaciously observed, consulting the statute provides a powerful remedy.[347]

VII. CONCLUSION

The rapid advancement of artificial intelligence is entering unknown territory. Legal systems around the world are now in a global artificial intelligence revolution. Artificial intelligence displays certain characteristics that raise the question of whether the implicit *de facto* requirements presently imposed by the patent eligibility

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337.   *Id.*

338.   *Id.*

339.   Decision of the European Patent Office, Technical Board of Appeal, Case T 22/85 - 3.5.1, Reasons for the Decision ¶ 12 (Oct. 5, 1988), http://www.epo.org/law-practice/case-law-appeals/pdf/t850022ep1.pdf.

340.   *See* Sadao Nagaoka, *Reform of Patent System in Japan and Challenges*, *in* 21ST CENTURY INNOVATION SYSTEMS FOR JAPAN AND THE UNITED STATES: LESSONS FROM A DECADE OF CHANGE: REPORT OF A SYMPOSIUM 153 (The National Academies Press 2009) (noting several important changes to the patent system that have taken place in Japan since the 1970s).

341.   *See, e.g.*, KAZUHIKO TAKEDA, THE KNOWLEDGE OF PATENTS 31 (8th ed. 2006) (translation by author).

342.   *See id.* (translation by author).

343.   *Id.* at 31–33 (translation by author).

344.   *See supra* Parts VI.A–VI.C.

345.   Singapore Patents Act, ch. 221, Art. 13(3) (2005).

346.   *See, e.g.*, CLS Bank Int'l. v. Alice Corp. Pty., 717 F.3d 1269, 1335 (Fed. Cir. 2013).

347.   *See id.* at 1335 ("And the remedy is the same: consult the statute! The statute offers a patent to both inventions and discoveries, including simply an improvement on a known process or product.").

jurisprudence can realistically be met by burgeoning artificial intelligence inventions.

Nevertheless, the future is bright because the patent eligibility jurisprudence under the laws of the United States, the European Patent Convention, France, Japan, and Singapore has evinced a certain degree of versatility. This flexibility enables the patent eligibility jurisprudence to evolve in response to the technical and societal changes associated with the vibrant development of artificial intelligence. Patent eligibility laws are therefore capable of undergoing a metamorphosis to encourage, stimulate, cheer, and reward courageous and strenuous endeavors to create artificial intelligence technology that is truly spectacular.