[1] 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019). https://www.uspto.gov/sites/default/files/documents/peg_oct_2019_update.pdf, https://www.federalregister.gov/documents/2019/10/18/2019-22782/october-2019-patent-eligibility-guidance-update. The substance of the 2019 PEG is included in the Manual of Patent Examining Procedure, 9th ed., rev. 10 (Jun. 2020) ("MPEP"). *See* MPEP § 2106.04(a) (9th ed. Rev. 10, June 2020) under "Abstract Ideas."

[2] *See* the 2019 PEG: "The 2019 PEG defines 'mathematical concepts' as mathematical relationships, mathematical formulas or equations, and mathematical calculations." 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 52. USPTO, of course, relies on case law, such as *Parker v. Flook*, 437 U.S. 584, 585 (1978), for the definitions provided in its guidelines. *See* n 11 of the 2019 PEG.

[3]The dictionary definition of Algorithm provides: "a procedure for solving a mathematical problem (as of finding the greatest common divisor) in a finite number of steps that frequently involves repetition of an operation broadly: a step-by-step procedure for solving a problem or accomplishing some end." https://www.merriam-webster.com/dictionary/algorithm (last visited Nov. 25, 2020).

[4] *See* the Wikipedia definition of algorithm: "In mathematics and computer science, an **algorithm** (/ˈælgərɪðəm/ (listen)) is a finite sequence of well-defined, computer-implementable instructions, typically to solve a class of problems or to perform a computation. … The word *algorithm* itself is derived from the 9th-century mathematician Muḥammad ibn Mūsā al-Khwārizmī, Latinized *Algoritmi*.[14] A partial formalization of what would become the modern concept of algorithm began with attempts to solve the *Entscheidungsproblem* (decision problem) posed by David Hilbert in 1928. …" https://en.wikipedia.org/wiki/Algorithm, (last visited Aug. 14, 2020).

[5] *See, e.g., Parker v. Flook*, 437 U.S. 584, 589 (1978) ("Reasoning that an algorithm, or mathematical formula, is like a law of nature, *Benson* applied the established rule that a law of nature cannot be subject of a patent."); *In re Bilski*, 545 U.S. 943, 952 (Fed. Cir. 2008) ("Noting that a mathematical algorithm alone is unpatentable because mathematical relationships are akin to a law of nature …."); *In re Bilski*, 545 U.S. 943, 953, n6 (Fed. Cir. 2008) (internal citations omitted)("Mathematical algorithms have, in other cases, been identified instead as abstract ideas rather than law of nature. Whether either or both views are correct is immaterial since both laws of nature and abstract ideas are unpatentable under § 101."); *Gottschalk v. Benson*, 409 U.S. 63, 65 (1972) ("The patent sought is a method of programming a general-purpose digital computer to convert signals from binary-coded decimal form into pure binary form. A procedure for solving a given type of mathematical problem is known as an 'algorithm.' The procedures set forth in the present claims are of that kind; that is to say, they are a generalized formulation for programs to solve mathematical problems of converting one form of numerical representation to another. From the generic formulation, programs may be developed as specific applications.").

[6] *See* the need for something "significantly more" than the so called "abstract idea" in MPEP § 2106 (9th ed. Rev. 10, June 2020) (emphasis added):

> I. TWO CRITERIA FOR SUBJECT MATTER ELIGIBILITY First, the claimed invention must be to one of the four statutory categories. 35 U.S.C. 101 defines the four categories of invention that Congress deemed to be the appropriate subject matter of a patent: processes, machines, manufactures and compositions of matter. The latter three categories define "things" or "products" while the first category defines "actions" (i.e., inventions that consist of a series of steps or acts to be performed). See 35 U.S.C. 100(b) ("The term 'process' means process, art, or method, and includes a new use of a known process, machine, manufacture, composition of matter, or material."). See MPEP § 2106.03 for detailed information on the four categories. Second, the claimed invention also must qualify as patent-eligible subject matter, i.e., the claim must not be directed to a judicial exception **unless the claim as a whole includes additional limitations amounting to significantly more** than the exception. The judicial exceptions (also called "judicially recognized exceptions" or simply "exceptions") are subject matter that the courts have found to be outside of, or exceptions to, the four statutory categories of invention, and are limited to abstract ideas, laws of nature and natural phenomena (including products of nature). Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208, 216, 110 USPQ2d 1976, 1980 (2014) (citing Ass'n for Molecular Pathology v.

Myriad Genetics, Inc., 569 U.S. 576, 589, 106 USPQ2d 1972, 1979 (2013). See MPEP § 2106.04 for detailed information on the judicial exceptions.

See also MPEP 2106.05 Eligibility Step 2B: Whether a Claim Amounts to Significantly More (9th ed. Rev. 10, June 2020). https://www.uspto.gov/web/offices/pac/mpep/s2106.html#ch2100_d29a1b_13c11_1cb.

[7] *See* 35 U.S.C § 102 (2013), 35 U.S.C § 103 (2013), and 35 U.S.C § 112 (2013).

[8] The IPWatchdog article by Jose Nunez, published in two parts, dated April 27, 2020 and May 1, 2020, expresses this argument quite well. Jose Nunez, "The Long Reach of the Mathematics Patentability Exception is Overbroad and Absurd- Part 1 and Part II." https://www.ipwatchdog.com/2020/04/27//long-reach-mathematics-patentabiliy-exception-overbroad-part-1/id=120955/.

[9] Fourier Transform is an example of a "Tool." https://en.wikipedia.org/wiki/Fourier_transform. (last visited Nov. 23, 2020). The various techniques of Linear Algebra, which includes the use of matrices and matrix operations, fall under the Tool type because of the wide and disparate range of scientific areas to which they are equally applicable. https://en.wikipedia.org/wiki/Linear_algebra, (last visited Nov. 23, 2020). Numerical analysis methods such as Finite Difference and Finite Element methods of solving engineering problems are also examples of Tools. https://en.wikipedia.org/wiki/Numerical_analysis, https://en.wikipedia.org/wiki/Finite_difference_method, https://en.wikipedia.org/wiki/Finite_element_method, (last visited Nov. 23, 2020).

[10] For example, Fourier Transform is a key tool in various technologies. *See* Fourier Transforms: High-tech Application and Current Trends. (2017). Croatia: IntechOpen. https://www.intechopen.com/books/fourier-transforms-high-tech-application-and-current-trends, (last visited Nov. 28, 2020).

[11] *See* MPEP § 2106.04(b) (I) (9th ed. Rev. 10, June 2020) (emphasis added):

> The law of nature and natural phenomenon exceptions reflect the Supreme Court's view that the basic tools of scientific and technological work are not patentable, because the "manifestations of laws of nature" are "part of the storehouse of knowledge," "free to all men and reserved exclusively to none." *Funk Bros. Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127, 130, 76 USPQ 280, 281 (1948). Thus, "a new mineral discovered in the earth or a new plant found in the wild is not patentable subject matter" under Section 101. Diamond v. Chakrabarty, 447 U.S. 303, 309, 206 USPQ 193, 197 (1980). "**Likewise, Einstein could not patent his celebrated law that E=mc2; nor could Newton have patented the law of gravity**." Id. Nor can one patent "a novel and useful mathematical formula," Parker v. Flook, 437 U.S. 584, 585, 198 USPQ 193, 195 (1978); electromagnetism or steam power, O'Reilly v. Morse, 56 U.S. (15 How.) 62, 113-114 (1853); or "[t]he qualities of ... bacteria, ... the heat of the sun, electricity, or the qualities of metals," Funk, 333 U.S. at 130, 76 USPQ at 281; see also Le Roy v. Tatham, 55 U.S. (14 How.) 156, 175 (1853).

https://www.bitlaw.com/source/mpep/2106_04_b.html.

[12] Newton's Second Law of motion expressed as F=ma is an example of a "Model." https://www.khanacademy.org/science/physics/forces-newtons-laws/newtons-laws-of-motion/a/what-is-newtons-second-law (last visited Nov. 23, 2020). Other examples include Hooke's Law of elasticity, expressed as F = kx, and the Fick's Law of Diffusion. https://www.britannica.com/science/Hookes-law (last visited Nov. 23, 2020). https://en.wikipedia.org/wiki/Fick%27s_laws_of_diffusion (last visited Nov. 23, 2020).

[13] Note the various infiltration[1] Note the various infiltration equations that are all intended to represent the very same single natural physical phenomenon of infiltration of water in soil: Richards' equation, Finite water-content vadose zone flow method, Horton's equation, Green and Ampt, Kostiakov's equation, and Darcy's Law. https://en.wikipedia.org/wiki/Infiltration_(hydrology) (last visited Nov. 25, 2020). The variety of equations

indicates that they are each an approximate model. The EPA site, in comparison, lists SCS Model, Philip's Two-Term Model, Layered Green Ampt Model, Explicit Green Ampt Model, Constant Flux Green Ampt Model, and Infiltration/Exfiltration Model. https://www.epa.gov/water-research/infiltration-models (last visited Nov. 25, 2020). Wallender, W. W. 1986. Furrow model with spatially varying infiltration. Transactions of the American Society of Agricultural Engineers 29(4):1012-1016. Grismer, M.E., K.C. Tarboton, and W.W. Wallender. 1998. Integrated modeling of regional-scale irrigation/drainage management. (Eds) Dudley Lynn M. and John C. Guitjens. Agroecosystems and the Environment: Sources, Control, and Remediation of Potentially Toxic, Trace Element Oxyanions. Pacific Division of the American Association for the Advancement of Science. p. 137-157.

[14] *See* MPEP § 2106.06 (1) (9th ed. Rev. 10, June 2020) (emphasis added). https://www.uspto.gov/web/offices/pac/mpep/s2106.html ("The concern over preemption was expressed as early as 1852. *See Le Roy v. Tatham*, 55 U.S. (14 How.) 156, 175 (1852) ("A principle, in the abstract**, is a fundamental truth**; an original cause; a motive; these cannot be patented, as no one can claim in either of them an exclusive right.").")

[15] As humans we may not be privy to the full truth of the "physical phenomena" and rather to some cartoonish version perceived by our limited means. *Cf.* Manual of Patent Examining Procedure, MPEP § 2106.04(b) (9th ed. Rev. 10, June 2020). https://www.bitlaw.com/source/mpep/2106_04_b.html; https://www.uspto.gov/web/offices/pac/mpep/s2106.html#ch2100_d29a1b_13b6b_4c

> Laws of nature and natural phenomena, as identified by the courts, include naturally occurring principles/relations and nature-based products that are naturally occurring or that do not have markedly different characteristics compared to what occurs in nature. The courts have often described these exceptions using other terms, including **"**physical phenomena," "scientific principles", "natural laws," and "products of nature."

[16] For a paper supporting the patentability of mathematical algorithms although not for the reasons set forth here, see Paul B. de Laat, "Patenting mathematical algorithms: What's the harm?: A thought experiment in algebra, International Review of Law and Economics," Volume 20, Issue 2, 2000, Pages 187-204, ISSN 0144-8188, https://doi.org/10.1016/S0144-8188(00)00031-4. (http://www.sciencedirect.com/science/article/pii/S0144818800000314)

[17] The USPTO October 2020 report on AI concluded that Many commentators agreed that **AI had no universally recognizable definition**. Public views on artificial intelligence and intellectual property policy, October 2020. https://www.uspto.gov/sites/default/files/documents/USPTO_AI-Report_2020-10-07.pdf.

[18] *See also,* Ebrahim, Tabrez, Artificial Intelligence Inventions & Patent Disclosure (October 31, 2020). Penn State Law Review, Vol. 125, No. 1, 2020, Available at SSRN: https://ssrn.com/abstract=3722720 stating at p.165:

> The speculative discussion of AI is fraught with unsupported assumptions and thus requires definition and demystification. **AI is difficult to define** but generally refers to the use of computing systems for automating tasks that would normally require human intelligence. The varying definitions of AI diffused the concept into meaningless buzz, and the definition also changed with time due to rapid technological developments.

(Emphasis added.)

[19] In *Brunton and Kutz*, "Artificial Intelligence" is defined as being based on machine learning Algorithms:

> In an integrated system, such as is found in autonomous robotics, various machine learning components (e.g., for processing visual and tactile stimulus) can be integrated to form what we now call artificial intelligence (AI). To be explicit: AI is built upon integrated machine learning algorithms, which in turn are fundamentally rooted in optimization.

Brunton, Steven L.; Kutz, J. Nathan (2019). Data-Driven Science and Engineering. Cambridge: Cambridge University Press. ISBN 978-1-108-42209-3. P. 178, Chapter 5. http://databookuw.com/.

[20] Arguments regarding an enhanced disclosure standard including the algorithms for AI inventions support our point that algorithms are a key aspect of such inventions. *See* Ebrahim, Tabrez, Artificial Intelligence Inventions & Patent Disclosure (October 31, 2020). Penn State Law Review, Vol. 125, No. 1, 2020, Available at SSRN: https://ssrn.com/abstract=3722720.

[21] This conclusion contradicts the arguments for patentability of the machine-generated outputs. *See* letter dated November 5, 2019 by Professor Ryan Abbott of the University of Surrey to Director Iancu at https://www.uspto.gov/sites/default/files/documents/Ryan-Abbott_RFC-84-FR 44889.pdf#:~:text=Ryan%20Abbott%2C%20I%20Think%2C%20Therefore%20I%20Invent%3A%20Creative,to%20at%20least%20the%201960s.%20A%20partial%20list.

[22] *Cf.* Abbott, Ryan Benjamin, I Think, Therefore I Invent: Creative Computers and the Future of Patent Law. Boston College Law Review, Vol. 57, No. 4, 2016, Available at SSRN: https://ssrn.com/abstract=2727884 or http://dx.doi.org/10.2139/ssrn.2727884.

[23] Jose Nunez, "The Long Reach of the Mathematics Patentability Exception is Overbroad and Absurd- Part 1 and Part II." https://www.ipwatchdog.com/2020/04/27//long-reach-mathematics-patentabiliy-exception-overbroad-part-1/id=120955/.

[24] *Id.* (emphasis in original).

[25] 2019 PEG, p. 52. https://www.uspto.gov/sites/default/files/documents/peg_oct_2019_update.pdf , https://www.federalregister.gov/documents/2019/10/18/2019-22782/october-2019-patent-eligibility-guidance-update. See also MPEP § 2106.04(a) Abstract Ideas (9th ed. Rev. 10, June 2020).

[26] *See* the 2019 PEG definition and MPEP § 2106.04(a) (9th ed. Rev. 10, June 2020).

[27] S*ee, e.*g., *State Street Bank and Trust Company v. Signature Financial Group, Inc*., 149 F.3d 1368, 1373 (Fed. Cir. 1998):

> The "Mathematical Algorithm" Exception
> The Supreme Court has identified three categories of subject matter that are unpatentable, namely "laws of nature, natural phenomena, and abstract ideas." Diehr, 450 U.S. at 185, 101 S.Ct. 1048. Of particular relevance to this case, the Court has held that **mathematical algorithms** are not patentable subject matter to the extent that they are merely abstract ideas. See Diehr, 450 U.S. 175, 101 S.Ct. 1048, passim; Parker v. Flook, 437 U.S. 584, 98 S.Ct. 2522, 57 L.Ed.2d 451 (1978); Gottschalk v. Benson, 409 U.S. 63, 93 S.Ct. 253, 34 L.Ed.2d 273 (1972).
> In Diehr, the Court explained that certain types of **mathematical subject matter**, standing alone, represent nothing more than abstract ideas until reduced to some type of practical application, i.e., "a useful, concrete and tangible result." Alappat, 33 F.3d at 1544, 31 USPQ2d at 1557.4.

(Emphasis added.)

[28] A particular "practical application" of a so-called fundamental principle is patent eligible: "The Court in *Diehr* thus drew a distinction between those claims that 'seek to pre-empt the use of' a fundamental principle, on the one hand, and **claims that seek only to foreclose others from using a particular 'application' of that fundamental principle**, on the other." *In re Bilski*, 545 U.S. 943, 953 (Fed. Cir. 2008) (emphasis added). https://www.leagle.com/decision/20081488545af3d94311488.

[29] *State Street Bank and Trust Company v. Signature Financial Group, Inc.*, 149 F.3d 1368, 1373 (Fed. Cir. 1998) (emphasis added) ("Today, we hold that the transformation of data, representing discrete dollar amounts, by a machine **through a series of mathematical calculations** into a final share price, **constitutes a practical application of a mathematical algorithm**, formula, or calculation, because it produces 'a useful, concrete and tangible result'—a final share price momentarily fixed for recording and reporting purposes and even accepted and relied upon by regulatory authorities and in subsequent trades.").

[30] "35 U.S.C. 101 Inventions patentable. Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title." MPEP, Appendix L, Patent Laws (9th ed. Rev. 10, June 2020).
https://mpep.uspto.gov/RDMS/MPEP/current#/result/d0e302376.html?q=35%20usc101&ccb=on&ncb=off&icb=off&fcb=off&ver=current&syn=or&results=compact&sort=relevance&cnt=25

[31] The filters used in signal processing are programmed into the process and are more like a Nail that ends up as part of the Chair. "Digital filters operate on signals represented in digital form. The essence of a digital filter is that it directly implements a mathematical algorithm, corresponding to the desired filter transfer function, in its programming or microcode." https://en.wikipedia.org/wiki/Filter_(signal_processing) (last visited Nov. 25, 2020).

[32] A new Hammer is patentable, but a new "law of nature" is not whereas both Hammer and the "law of nature" are generally means to an end. *Cf. Funk Brothers Seed Co. v. Kalo Inoculant Co.,* 333 U.S. 127, 333 (1948) ("The qualities of these bacteria, like the heat of the sun, electricity, or the qualities of metals, are part of the storehouse of knowledge of all men. They are manifestations of laws of nature, free to all men and reserved exclusively to none. He who discovers a hitherto unknown phenomenon of nature has no claim to a monopoly of it which the law recognizes. If there is to be invention from such a discovery, it must come from the application of the law of nature to a new and useful end.").

[33] Brunton, Steven L.; Kutz, J. Nathan (2019). Data-Driven Science and Engineering. Cambridge: Cambridge University Press. ISBN 978-1-108-42209-3. P. 178. http://databookuw.com/databook.pdf.

[34] *Brunton and Kutz*, Preface, p. vi.

[35] Judge Paul Michel & John Battaglia. "Flaws in the Supreme Court's §101 Precedent and Ways to Correct Them." https://www.ipwatchdog.com/2020/04/27/flaws-supreme-courts-%C2%A7101-precedent/id=121038/. In Section "A. Diehr Distinguishes Flook (1978) and Benson (1972)" Judge Michel states: "Moreover, Diehr explained that the Court's then-recent precedents on these §101 exceptions stood 'for no more than these [same] long-established principles.' … The dispute and analysis in those cases focused then **on a point which no one disputes today, viz., whether an algorithm 'itself' was ineligible subject matter**. E.g., Benson, 409 U.S. at 67-72. 'In contrast,' said the Court, Diehr's multi-step claims 'do not seek to patent a mathematical formula or other patent-ineligible concept.'" (emphasis added.)

[36] *Brunton and Kutz*, Preface, p. vii.
[37] *Brunton and Kutz*, Preface, p. vii.
[38] *Brunton and Kutz*, Chapter 1, Singular Value Decomposition, 1.1. Overview, p. 7.
[39] *Brunton and Kutz*, Chapter 2, Fourier and Wavelet Transforms, p. 54.

[40] Note the definition of "Algorithm" from Wikipedia which demands an exact nature: "In mathematics and computer science, an algorithm (/ˈælgərɪðəm/ (About this soundlisten)) is **a finite sequence of well-defined, computer-implementable instructions**, typically to solve a class of problems or to perform a computation.[1][2] **Algorithms are always unambiguous** and are used as specifications for performing calculations, data processing, automated reasoning, and other tasks." https://en.wikipedia.org/wiki/Algorithm, (last visited Aug. 14, 2020).

[41] *Cf. State Street Bank and Trust Company v. Signature Financial Group, Inc.*, 149 F.3d 1368, 1373 (Fed. Cir. 1998) (presenting a "fair is foul and foul is fair" type of argument and condemning the algorithms with broader utility as not useful: **"Unpatentable mathematical algorithms** are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that **are not 'useful.'** From a practical standpoint, this means that to be patentable an algorithm must be applied in a 'useful' way. In Alappat, we held that data, transformed by a machine through a series of mathematical calculations to produce a smooth waveform display on a rasterizer monitor, constituted **a practical application** of an abstract idea (a mathematical algorithm, formula, or

calculation), because it produced 'a useful, concrete and tangible result'-the smooth waveform. Similarly, in Arrhythmia Research Technology Inc. v. Corazonix Corp., 958 F.2d 1053, 22 USPQ2d 1033 (Fed.Cir.1992), we held that the transformation of electrocardiograph signals from a patient's heartbeat by a machine through a series of mathematical calculations constituted **a practical application** of an abstract idea (a mathematical algorithm, formula, or calculation), because it corresponded to a useful, concrete or tangible thing-the condition of a patient's heart." (emphasis added.)).

[42] Note that the rationale of "preemption" for basic or fundamental tools of science as a part of "storehouse of knowledge" that must be available to all and reserved to none is not sound when it applies to something that is unknown and nonobvious and therefore not previously available at the storehouse. *Accord*, "Alice is the most recent Supreme Court pronouncement on Section 101, and with it the Court reiterated that the test of eligibility was not non-preemption, but 'inventive concept'—and that, after eliminating the implied exception from the analysis and looking to see if the remaining limitations of the claim contained 'something more' that was sufficient 'to transform' it into an eligible invention. As with 'abstract concept,' no definition was provided for what 'something more' meant. And like 'abstract,' it was explicitly described as a relative notion because both opinions acknowledged that all inventions can be reduced to abstractness if one went far enough." "Is 2019 the Year Clarity Returns to Section 101? Judge Paul Michel Is Hopeful." IPWatchdog, https://www.ipwatchdog.com/2019/01/24/2019-year-clarity-returns-section-101-judge-paul-michel-hopeful/id=105566/.

[43] Obviously, we do not hear of the mathematical models that do not see the light of day. However, to demonstrate the point that there are more ways to crack a nut than one, Euclidian Geometry, which is commonly taught in schools, can be contrasted to Non-Euclidean Geometries, of which most are generally unaware. Euclidian Geometry builds on a postulate that from a point outside a line only a single line may be drawn parallel to the first line. Non-Euclidian Geometries permit an infinite number of lines where Euclidian Geometry permitted a single line. The co-existence of these two starkly different models points away from any fundamental truths and hints of a construct and a model. In this case, each model is useful in its own right. "The essential difference between the metric geometries is the nature of parallel lines. Euclid's fifth postulate, the parallel postulate, is equivalent to Playfair's postulate, which states that, within a two-dimensional plane, for any given line l and a point A, which is not on l, there is exactly one line through A that does not intersect l. In hyperbolic geometry, by contrast, there are infinitely many lines through A not intersecting l, while in elliptic geometry, any line through A intersects l." https://en.wikipedia.org/wiki/Non-Euclidean_geometry (last visited Nov. 26, 2020).

[44] *Diamond v. Chakrabarty*, 447 U.S. 303, 309 (1980) (internal citations omitted) ("The laws of nature, physical phenomena, and abstract ideas have been held not patentable. Thus, a new mineral discovered in the earth or a new plant found in the wild is not patentable subject matter. Likewise, Einstein could not patent his celebrated law that $E=mc^2$; nor could Newton have patented the law of gravity. Such discoveries are manifestations of ... nature, free to all men and reserved exclusively to none."). https://supreme.justia.com/cases/federal/us/447/303/.

[45] Definition of Theory from Wikipedia:

> In modern science, the term "theory" refers to scientific theories, a **well-confirmed type of explanation of nature**, made in a way consistent with scientific method, and fulfilling the criteria required by modern science. Such theories are described in such a way that scientific tests should be able to provide empirical support for it, or empirical contradiction ("falsify") of it. Scientific theories are the most reliable, rigorous, and comprehensive form of scientific knowledge,[1] in contrast to more common uses of the word "theory" that imply that something is unproven or speculative (which in formal terms is better characterized by the word hypothesis).[2] Scientific theories are distinguished from hypotheses, which are individual empirically testable conjectures, and from scientific laws, which are descriptive accounts of the way nature behaves under certain conditions.

https://en.wikipedia.org/wiki/Theory, (last visited Aug. 14, 2020) (emphasis added).

[46] Definition of Scientific Laws from Wikipedia:

> Scientific laws or laws of science are statements, based on repeated experiments or observations, that describe or predict a range of natural phenomena.[1] The term law has diverse usage in many cases (approximate, accurate, broad, or narrow) across all fields of natural science (physics, chemistry, astronomy, geoscience, biology). Laws are developed from data and can be further developed through mathematics; in all cases they are directly or indirectly based on empirical evidence. It is generally understood that they implicitly reflect, though they do not explicitly assert, causal relationships fundamental to reality, and are discovered rather than invented.

https://en.wikipedia.org/wiki/Scientific_law, (last visited Aug. 14, 2020).

[47] *See* Sean Carroll, "Something Deeply Hidden: Quantum Worlds and the Emergence of Spacetime a Brief History of Quantum Mechanics - with Sean Carroll," Dulton, 2019, ISBN 978-1524743017. *See also,* Sean Carrol, "A Brief History of Quantum Mechanics." https://youtu.be/5hVmeOCJjOU.

[48] Note the concurring opinion of Justice Frankfurter in *Funk Brothers Seed Company v. Kalo Inoculant Company*, 333 U.S. 127 (1948). The claim was a product claim to a mixture of bacteria that could be used to naturally fertilize the soil without inhibiting the growth and effectiveness of one another. The majority resorted to a law of nature analysis and held the claim invalid for falling within the exclusion of laws of nature from patentability: "Discovery of the fact that certain strains of each species of the bacteria can be mixed without harmful effects to the properties of either is a discovery their qualities of non-inhibition. It is no more than the discovery of some of the handiwork of nature and hence it is not patentable." *Funk Bros. Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127, 131 (1948). Justice Frankfurter, in his concurring opinion, agreed that the claim was invalid. Justice Frankfurter, however, found resorting to the law of nature analysis as confusing the issue: "It only confuses the issue, however, to introduce such terms as 'the work of nature' and the 'laws of nature.' For these are vague and malleable terms infected with too much ambiguity and equivocation. **Everything that happens may be deemed 'the work of nature,' and any patentable composite exemplifies in its properties 'the laws of nature.'** Arguments drawn from such terms for ascertaining patentability could fairly be employed to challenge almost every product." *Funk Bros. Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127, 134, 135 (1948) (Frankfurter, J., concurring) (emphasis added). https://supreme.justia.com/cases/federal/us/333/127/.

[49] The Indian story of the blind men and the elephant is apt in the context of the so-called "Laws of Nature." https://mythgyaan.com/blind-men-and-the-elephant/#:~:text=This%20earliest%20parable%20%28%E0%A4%A6%E0%A5%83%E0%A4%B7%E0%A5%8D%E0%A4%9F%E0%A4%BE%E0%A4%82%E0%A4%A4%29%20of%20this%20story%20is,there%20is%20an%20elephant%20in%20the%20village%20today. (last visited, No. 28, 2020.)

[50] Stephanie Skaff, James Day, Laura Pedersen, Ashleigh Nickerson, "Artificial Intelligence Can't Patent Inventions: So What?" July 13, 2020. https://www.ipwatchdog.com/2020/07/13/artificial-intelligence-cant-patent-inventions/id=123226/

[51] Kirk Hartung, "Dear USPTO: Patents for Inventions by AI Must Be Allowed." May 21, 2020. https://www.ipwatchdog.com/2020/05/21/dear-uspto-patents-inventions-ai-must-allowed/id=121784/.

[52] *Brunton and Kutz*, Chapter 4, Regression and Model Selection, p. 134.

[53] Examples of case law regarding the exception of mathematical concepts as provided by the USPTO, 2019 PEG:

> "Bilski v. Kappos, 561 U.S. 593, 611 (2010) (''The concept of hedging . . . reduced to a mathematical formula . . . is an unpatentable abstract idea[.]''); Diamond v. Diehr, 450 U.S. 175, 191 (1981) (''A mathematical formula as such is not accorded the protection of our patent laws'') (citing Benson, 409 U.S. 63); Parker v. Flook, 437 U.S. 584, 594 (1978) (''[T]he discovery of [a mathematical formula] cannot support a patent unless there is some other inventive concept in its application.''); Benson, 409 U.S. at 71–72 (concluding that permitting a patent on the claimed invention ''would wholly pre-empt the mathematical formula and in practical effect would be a

patent on the algorithm itself''); Mackay Radio & Telegraph Co. v. Radio Corp. of Am., 306 U.S. 86, 94 (1939) (''[A] scientific truth, or the mathematical expression of it, is not patentable invention[.]''); SAP America, Inc. v. InvestPic, LLC, 898 F.3d 1161, 1163 (Fed. Cir. 2018) (holding that claims to a ''series of mathematical calculations based on selected information'' are directed to abstract ideas); Digitech Image Techs., LLC v. Elecs. for Imaging, Inc., 758 F.3d 1344, 1350 (Fed. Cir. 2014) (holding that claims to a ''process of organizing information through mathematical correlations'' are directed to an abstract idea); Bancorp Servs., LLC v. Sun Life Assurance Co. of Can. (U.S.), 687 F.3d 1266, 1280 (Fed. Cir. 2012) (identifying the concept of ''managing a stable value protected life insurance policy by performing calculations and manipulating the results'' as an abstract idea)."

84 Fed. Reg. 52, n 12 (Jan. 7, 2019).
https://www.uspto.gov/sites/default/files/documents/peg_oct_2019_update.pdf

[54] *Cf.* Abbott, Ryan Benjamin, I Think, Therefore I Invent: Creative Computers and the Future of Patent Law. Boston College Law Review, Vol. 57, No. 4, 2016, Available at SSRN: https://ssrn.com/abstract=2727884 or http://dx.doi.org/10.2139/ssrn.2727884.