Note

When the Invention Is an Inventor: Revitalizing Patentable Subject Matter to Exclude Unpredictable Processes

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In the movie *I, Robot*, renegade androids use their artificial intelligence to unleash death and destruction on their human creators.[1] Although such catastrophic consequences may be little more than fanciful entertainment, technology capable of independent creative problem-solving does highlight some very real concerns. Creative thinking and invention today remain primarily human functions, but increasingly capable computers are beginning to encroach. Already, systems such as genetic algorithms allow computers to autonomously generate "real world" inventions.[2] As computers grow more powerful, they will take on an increasing proportion of the creative, problem-solving work previously reserved for human engineers.

This paradigm shift demands a reexamination of the *type* of abstract innovations that should be patent-eligible. The Patent Act defines patentable subject matter in 35 U.S.C. § 101,[3]

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1. *See* I, ROBOT (20th Century Fox 2004).

2. *See, e.g.*, JOHN R. KOZA ET AL., GENETIC PROGRAMMING III: DARWINIAN INVENTION AND PROBLEM SOLVING 5 (1999) ("[G]enetic programming has automatically created a computer program that is competitive with a human-produced result."); Jonathon Keats, *John Koza Has Built an Invention Machine*, POPULAR SCI., May 2006, at 66, 72 (describing how a genetic algorithm independently and autonomously generated several different circuit designs that had been previously patented by human designers).

3. Patentable subject matter is defined as "any new and useful process, machine, [article of] manufacture, or composition of matter, or any new and useful improvement thereof." 35 U.S.C. § 101 (2000).

but in practice courts have found the definition to be highly elastic.[4] With three recent decisions, however, the Federal Circuit has given the law governing patentable subject matter new relevance.[5] Artificial creativity provides a particularly useful lens through which to analyze the proper limits of this tortured and tangled area of jurisprudence.

In each of the three Federal Circuit cases, the parties argued over the appropriate role of devices traditionally used to limit patentability under § 101. These include restricting patentable subject matter to technological arts,[6] requiring that an abstract process be tied to a tangible machine such as a computer,[7] and precluding patenting of purely mental steps.[8] Such barriers are unlikely to significantly impede the patentability of artificial creativity.[9] And yet, by raising the potential of pa-

4. *See, e.g.*, Diamond v. Chakrabarty, 447 U.S. 303, 308–09 (1980) (finding a live, human-made organism patentable under § 101); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1373–75 (Fed. Cir. 1998) (finding a method for conducting business to be patentable under § 101); Michael A. Carrier, *Cabining Intellectual Property Through a Property Paradigm*, 54 DUKE L.J. 1, 4 (2004) ("The duration and scope of IP rights expand without limit."); John R. Thomas, *The Patenting of the Liberal Professions*, 40 B.C. L. REV. 1139, 1160 (1999) ("[Subject-matter doctrine] seemingly bars few, if any, applications for patent. After *State Street*, it is hardly an exaggeration to say that if you can name it, you can claim it.").

5. *See In re* Comiskey, 499 F.3d 1365, 1378 (Fed. Cir. 2007) (finding business methods that "depend for their operation on human intelligence alone" unpatentable under § 101); *In re* Nuijten, 500 F.3d 1346, 1357 (Fed. Cir. 2007) (finding an electrical signal unpatentable under § 101); *In re* Bilski, 264 F. App'x 896, 897 (Fed. Cir. 2008) (ordering a hearing en banc to decide whether a particular business method is patentable under § 101).

6. *Compare* Appellants' Supplemental Brief at 11–12, *In re* Bilski, No. 2007-1130 (Fed. Cir. Mar. 6, 2008) (arguing that a risk-managing business method is part of the technological arts, and, alternatively, that the USPTO explicitly disclaimed a technological arts requirement as an exclusive test in *Ex parte* Lundgren, 76 U.S.P.Q.2d 1385, 1388 (Patent & Trademark Office Bd. of Patent Appeals & Interferences Sept. 28, 2005)), *with* Supplemental Brief of Appellee at 10, *In re* Bilski, No. 2007-1130 (Fed. Cir. Mar. 6, 2008) ("[T]he technological focus of the Patent Act and the Patent Clause informs the outer limits of subject matter eligibility under section 101.").

7. *See In re Bilski*, 264 F. App'x at 897 (requesting the parties brief the issue of whether a statutory "process must result in a physical transformation of an article or be tied to a machine"); Supplemental Brief of Appellee, *supra* note 6, at 6–14 (arguing that a statutory process that does not effect a physical transformation must be "tied to a particular apparatus").

8. *See In re Comiskey*, 499 F.3d at 1378 ("It is thus clear that the present statute does not allow patents to be issued on particular business systems . . . that depend entirely on the use of mental processes.").

9. Inventions such as genetic algorithms are clearly part of the technological arts, must be performed in connection with a computer, and do not "de-

tenting a process that is itself capable of producing new invention, technologies such as genetic algorithms invoke the same general concern these Federal Circuit cases struggle with—potentially overbroad and innovation-chilling protection. Thus, an analysis of artificial creativity performs two useful functions. First, it illustrates the current lack of technology-independent, coherent, and consistent standards under § 101. Second, it serves as a handy proxy with which to test the adequacy of proposed tools to limit patentable subject matter.

Part I of this Note reviews the historical development and present state of subject-matter doctrine with particular emphasis on the convoluted history of software patentability. Part II analyzes creative algorithms as inventive processes and identifies costs associated with patenting them. It then applies current subject-matter doctrine to creative algorithms, demonstrating the doctrine's inadequacy. Part III posits that subject-matter doctrine is sufficiently vital in theory to limit patent coverage in the face of emerging technologies such as creative algorithms. Rendering the doctrine effective in practice, however, requires two changes in how the doctrine is applied. First, courts must apply common law limits on patentability solely as a means to ensure that society retains free access to the basic tools of science. Second, courts must limit statutory patentability under § 101 to only those inventions that produce predictable and replicable results when used. By separately analyzing what *is* patentable subject matter under § 101 and what *is not* under the common law, courts can effectively screen out those abstract inventions that would impermissibly chill future innovation if patented.

I. SUBJECT-MATTER DOCTRINE AND ARTIFICIAL INVENTORS

A. HISTORY AND PHILOSOPHY OF THE PATENT

A patent gives an inventor the right to "exclude others from making, using, offering for sale, or selling the invention" for a limited time.[10] Theorists justify this advantage with several distinct philosophical theories. A "natural rights" approach gives an inventor ownership of that with which he has "mixed his labour."[11] Intellectual property rights today are primarily

pend entirely on the use of mental processes." *See id.* at 1376–79.

10. 35 U.S.C. §§ 154(a)(1)–(2) (2000).

11. JOHN LOCKE, THE SECOND TREATISE ON CIVIL GOVERNMENT 20 (Pro-

justified with utilitarian theories.[12] The rights are simply means to an end—they give the inventor a monopoly over his invention for a limited time (the incentive to create) in exchange for public access to and later use of the knowledge (the public benefit).[13]

Because the incentive to create is a right to exclude, patent laws must limit the right to exclude to ensure the tools and resources needed to create in the first place remain freely available. At the same time, they must ensure that the right to exclude is robust enough to function as a real incentive to invent. The Constitution charges Congress with crafting this delicate balance.[14] Under current patent laws, an inventor must show that his invention is of a kind eligible for patent protection,[15] useful,[16] novel,[17] non-obvious,[18] and adequately enabled and described.[19] If an inventor fails to meet any one of these requirements, his invention is ineligible for the patent privilege.[20]

B. ADVANCING TECHNOLOGY: THE GROWTH OF SOFTWARE AND THE RISE OF CREATIVE ALGORITHMS

Whether and to what extent abstract innovations such as computer software are patentable is important now more than

metheus Books 1986) (1690); *see also* DONALD S. CHISUM ET AL., PRINCIPLES OF PATENT LAW 39–41 (3d ed. 2004) (discussing an inventor's "inherent right to the fruits of her labor").

12. CHISUM ET AL., *supra* note 11, at 50 ("[T]he predominant justification for American intellectual property law has been . . . utilitarianism.").

13. *See* Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 167 (1989) (noting that the patent statute seeks a "careful balance between public right and private monopoly to promote certain creative activity"); Graham v. John Deere Co., 383 U.S. 1, 9 (1966) ("The patent monopoly was not designed to secure to the inventor his natural right in his discoveries. Rather, it was a reward, an inducement, to bring forth new knowledge."). *But see* Maverick Boat Co. v. Am. Marine Holdings, Inc., 418 F.3d 1186, 1191 (11th Cir. 2005) (noting that Congress passed the Vessel Hull Design Protection Act of 1998, Pub. L. No. 105-304, 112 Stat. 2860 (codified as amended at 17 U.S.C. § 1301 (2006)), in response to *Bonito Boats* to provide copyright protection to the owners of certain vessel hull designs).

14. U.S. CONST. art. I, § 8, cl. 8 (granting Congress the power to "promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries").

15. *See* 35 U.S.C. § 101 (2000).

16. *See id.* §§ 101, 112.

17. *See id.* § 102.

18. *See id.* § 103.

19. *See id.* § 112.

20. *See id.* § 101.

ever for two reasons. First, the software industry views the software patent as an important business asset,[21] and predictability as to the viability of that asset is essential to long-term business success.[22] Second, emerging software enabling artificial creativity directly challenges definitions of invention and inventor, in addition to implicating traditional qualms related to software's inherent intangibility.

1. Software Patents: Why the Surge?

Software developers have increasingly exploited the incentives and protections patent law provides.[23] Indeed, the percentage of all granted patents that can be counted as software patents has risen dramatically, from two percent in the early 1980's to almost fifteen percent in 2002.[24] The growing number of software patents may be attributed in part to expanding software technology research and development activity.[25] Impressive growth of the software industry[26] has predictably resulted in an absolute increase in software innovation. Software giants IBM, AT&T, and Hewlett-Packard all rank in the top fifty of Fortune 500 companies.[27] Along with the absolute growth of the industry, however, has come an increasing appreciation for the perceived value of software patents and thus an increased propensity to patent.[28] A recent study attributed this increased propensity to patent primarily to courts' more favorable view towards software patentability.[29]

21. *See* JAMES BESSEN & ROBERT M. HUNT, AN EMPIRICAL LOOK AT SOFTWARE PATENTS 17 (2004), http://www.researchoninnovation.org/swpat.pdf (noting an increased propensity to patent software).

22. *See* Richard S. Gruner, *Intangible Inventions: Patentable Subject Matter for an Information Age*, 35 LOY. L.A. L. REV. 355, 361 (2002) ("Ambiguous patent law standards can lead to excessive curtailment of activities under overly broad threats of patent enforcement."); John A. Burtis, Comment, *Towards a Rational Jurisprudence of Computer-Related Patentability in Light of* In re Alappat, 79 MINN. L. REV. 1129, 1129 (1995) (noting that the marketplace makes business decisions based on the predicted protection available to technology).

23. Between 1978 and 1987, the USPTO issued 262 software patents. ROBERT PATRICK MERGES & JOHN FITZGERALD DUFFY, PATENT LAW AND POLICY: CASES AND MATERIALS 154 (4th ed. 2007). Currently, the number of software patents issued exceeds 20,000 every year. *See* JAMES BESSEN & ROBERT M. HUNT, THE SOFTWARE PATENT EXPERIMENT 1 (2004), http://www.researchoninnovation.org/softpat.pdf.

24. BESSEN & HUNT, *supra* note 23, at 5.

25. *But see* James Bessen & Robert M. Hunt, *An Empirical Look at Software Patents*, 16 J. ECON. & MGMT. STRATEGY 157, 180–83 (2007) (concluding that the increase in software patents is primarily the result of legal changes

Because software code is one of the "Writings" protected by the Constitution,[30] it is also generally afforded copyright protection.[31] The prevailing view, however, is that patents offer broader and more easily enforced property rights.[32] Copyright law does not allow the holder to exclude an author who independently creates a substantially similar work.[33] Copyright law also permits reverse-engineering of software.[34] Furthermore, the "fair use" doctrine allows others to reproduce the copyrighted work for "criticism, comment, news reporting, teaching . . . scholarship, or research."[35] Copyrights, however, do offer a much longer term of coverage than patents[36] and are much easier to obtain.[37]

that make the patents easier to acquire).

26. The total software industry research and development increased from "$121 billion in 1988 to $164 billion in 1998 in 1996 dollars." BESSEN & HUNT, *supra* note 21, at 17 n.21.

27. *Largest U.S. Corporations*, FORTUNE, May 5, 2008, at F1.

28. *See* BESSEN & HUNT, *supra* note 21, at 16–17 (noting that the number of U.S. software patents granted increased at about sixteen percent per year, while industrial investment in software research and development grew at only 4.4 percent per year during the same period).

29. *See* Bessen & Hunt, *supra* note 25, at 181 ("Eliminating the subject matter exclusion and reducing the nonobviousness and enablement requirements may have made software patents much easier (less costly) to obtain.").

30. *See* U.S. CONST. art. I, § 8, cl. 8; U.S. NAT'L COMM'N ON NEW TECHNOLOGICAL USES OF COPYRIGHTED WORKS, FINAL REPORT OF THE NATIONAL COMMISSION ON NEW TECHNOLOGICAL USES OF COPYRIGHTED WORKS 35–36 (1978) [hereinafter COPYRIGHTED WORKS REPORT].

31. Computer programs are copyrightable as long as they are recorded to a hard drive or some other tangible medium. *See* COPYRIGHTED WORKS REPORT, *supra* note 30, at 49.

32. *See* Donald S. Chisum, *The Patentability of Algorithms*, 47 U. PITT. L. REV. 959, 1015–16 (1986). *But see* Pamela Samuelson, Benson *Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 EMORY L.J. 1025, 1136 (1990) ("Many in the software industry believe copyright has a number of significant advantages over patents as a form of legal protection for programs.").

33. Thomas Caswell & Kimberly Van Amburg, *Copyright Protection on the Internet*, *in* E-COPYRIGHT LAW HANDBOOK 7-1, 7-8 (Laura Lee Stapleton ed., Supp. 2003) (noting that someone who independently creates an exact replica of another copyrighted work is also entitled to a copyright over that work).

34. Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1, 17 (2001) ("[V]irtually every court to consider the issue has concluded that there is a right to reverse engineer a copyrighted program for at least some purposes.").

35. 17 U.S.C. § 107 (2006).

36. In most cases, the copyright term is granted for the life of the author plus seventy years. *Id.* § 302(a). A patent, on the other hand, is enforceable for

2. Creative Algorithms: Development and Application

Conventional computer software alone has substantially challenged the law governing patentable subject matter. As technology continues to accelerate, however, research, discovery, and design work increasingly depend on computer programs to do not only the number-crunching but also the "thinking."[38] Emerging artificial intelligence technologies[39] highlight the importance of building a coherent subject-matter doctrine.

Software using artificial intelligence does not rely exclusively on a linear set of programming instructions—rather, it has some capacity to reason for itself.[40] "Expert systems" yielded some of the first practical applications of artificial intelligence research and continue to find useful application.[41] Software incorporating "neural networks" is a more refined application of artificial intelligence.[42] Recent technologies known as "genetic programming" or "evolutionary engineering" have arguably proven to be the most effective at replicating human creativity.[43] By applying Charles Darwin's principle of natural selection, computer programmers can write software that enables computers to creatively problem-solve.[44]

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only twenty years from filing. 35 U.S.C. § 154(a)(2) (2000).

37. The author of a written work obtains a copyright simply by creation—no official registration is required. 17 U.S.C. § 201(a) (2006).

38. *See* Liza Vertinsky & Todd M. Rice, *Thinking About Thinking Machines: Implications of Machine Inventors for Patent Law*, 8 B.U. J. SCI. & TECH. L. 574, 581 (2002).

39. The increasing utility of artificial intelligence technologies is enabled in large part by increases in computer hardware processing power. *See id.* at 578 (noting that computer processing power has doubled every eighteen months for the past thirty years).

40. *See id.* at 576 (noting that new "thinking machines" reason by automating the trial and error learning process).

41. *See* Todd Shuster, *Originality in Computer Programs and Expert Systems: Discerning the Limits of Protection Under Copyright Laws of France and the United States*, 5 TRANSNAT'L LAW. 1, 76 (1992).

42. *See* Dana S. Rao, Note, *Neural Networks: Here, There, and Everywhere—An Examination of Available Intellectual Property Protection for Neural Networks in Europe and the United States*, 30 GEO. WASH. J. INT'L L. & ECON. 509, 509 (1997) (explaining that a neural network can generalize information to solve novel problems beyond the scope of the network's original training).

43. *See* KOZA ET AL., *supra* note 2, at 5–7 (describing cases where artificial intelligence has produced inventions that rival those of humans).

44. *Id.* at 3.

Initially, a set of subprograms are randomly generated with the object of solving a particular problem.[45] Each subprogram attempts to solve the problem and is assigned a score based on how well it performed.[46] Those subprograms with the best scores are copied into a new population to be the "parents" of the next generation.[47] Simulated sexual reproduction creates the next generation of subprograms by randomly combining chosen features from two parents.[48] The process is repeated through a specified set of iterations, and the subprogram with the highest score is the optimal design or solution.[49] No one can predict the route to the optimal solution or the solution itself because the process incorporates random mutation.[50]

Whether creative software should be patentable is no longer simply an academic exercise—the Patent Office has already granted several patents claiming precisely these genetic programming algorithms.[51] John Koza, one of the pioneers of genetic programming technology, has patented not only genetic programming processes, but also designs produced by genetic programming.[52] Genetic programming has moved beyond laboratories, however. General Electric has used genetic algorithms to aid in the design of jet engines.[53] Engineers in Wisconsin are using genetic algorithms to optimize efficiency and minimize emissions for diesel engines.[54] Virginia engineers designed a novel and effective satellite communications antenna.[55] Furthermore, programs utilizing genetic programming are

45. *Id.* at 19–23.

46. *Id.*

47. *Id.*

48. *Id.*

49. *Id.* at 22. This design is often called the "best-so-far individual." *Id.*

50. *Id.* at 76 ("The genetic operation of mutation randomly alters one or more genes at particular locations along a preestablished fixed-size [algorithmic program].").

51. *See, e.g.*, Method and Apparatus for Automatic Synthesis, Placement and Routing of Complex Structures, U.S. Patent No. 6,424,959 (filed June 17, 1999); Method and Apparatus for Automated Design of Complex Structures Using Genetic Programming, U.S. Patent No. 6,360,191 (filed Jan. 5, 1999).

52. *See* Keats, *supra* note 2, at 72 (noting that on January 25, 2005, the USPTO granted a patent for a circuit designed by a genetic programming algorithm); *see also* Apparatus for Improved General-Purpose PID and Non-PID Controllers, U.S. Patent No. 6,847,851 (filed July 12, 2002).

53. *See* Ray Kurzweil, *The Virtual Thomas Edison*, TIME, Dec. 4, 2000, at 65.

54. *See Diesel Breeding: Looking Into Engines Helps Cross the Best with the Best*, MECHANICAL ENGINEERING, Sept. 2002, at 53.

55. *See* Anne Eisenberg, *When a Gizmo Can Invent a Gizmo*, N.Y. TIMES,

increasingly available in commercialized forms.[56] Although this technology remains far from ubiquitous,[57] it is emblematic of the kinds of challenges highly abstract inventions will present to the U.S. patent system in the coming years. These challenges, this Note argues, are most effectively met through application of § 101.

C. SUBJECT MATTER PATENTABILITY DOCTRINE: A BRIEF HISTORY

In § 101 of the Patent Act, Congress explicitly defined subject matter eligible for patent protection as any "process, machine, [article of] manufacture, or composition of matter."[58] The precise definition of a patentable "process" remains somewhat uncertain.[59] The Supreme Court has consistently interpreted the four statutory categories broadly—they encompass "anything under the sun that is made by man."[60] This generous interpretation, combined with subsequent court decisions consistently expanding the scope of patentable subject matter,[61] led some to conclude that the four statutory categories are "merely

Nov. 25, 1999, at G9.

56. *See* Gary H. Anthes, *Self-taught*, COMPUTERWORLD, Feb. 6, 2006, at 28; Peter Coffee, *'Exotic' Tools Go Mainstream*, EWEEK, Feb. 6, 2006, at D1 (discussing the development of programs such as Discipulus, a genetic programming engine, and NeuralTools, a program utilizing neural network software).

57. John Koza, one of the pioneers of the genetic engineering technology, noted that "sometime [within] 10 years we ought to be able to play in the domain of real engineers." Anthes, *supra* note 56, at 28.

58. 35 U.S.C. § 101 (2000). The present language is derived almost verbatim from the first Patent Act of 1793, with the only change being the substitution of the word "process" for the word "art." *See* Diamond v. Chakrabarty, 447 U.S. 303, 308–09 (1980).

59. The Supreme Court defined a "process" as "'an act, or a series of acts, performed upon the subject-matter to be transformed and reduced to a different state or thing.'" Gottschalk v. Benson, 409 U.S. 63, 70 (1972) (quoting Cochrane v. Deener, 94 U.S. 780, 787–88 (1876)). Actual physical transformation, however, "is not an invariable requirement." AT&T Corp. v. Excel Commc'ns, Inc., 172 F.3d 1352, 1358–59 (Fed. Cir. 1999).

60. *Chakrabarty*, 447 U.S. at 309 (citing S. REP. NO. 82-1979, at 5 (1952)); *see also* Sabrina Safrin, *Chain Reaction: How Property Begets Property*, 82 NOTRE DAME L. REV. 1917, 1919 (2007) ("Over the last several decades, knowledge, in particular, has undergone increased propertization . . . .").

61. *See* Diamond v. Diehr, 450 U.S. 175, 191–92 (1981) (finding computer programs to be patentable subject matter); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1375 (Fed. Cir. 1998) (finding business methods to be patentable subject matter).

representative."[62] Indeed, between 1995 and 2006, the Federal Circuit did not hold a single patent claim unpatentable under § 101.[63]

Not content to define what can be patented, the Supreme Court gradually carved out "[t]he laws of nature, physical phenomena, and abstract ideas" as distinctly unpatentable subject matter under the common law.[64] Courts consistently cite the need to keep the basic tools of scientific research available to all as the primary justification for these exclusionary categories.[65] Some commentators understand these categories to merely reflect a preference for applied research—a judicial gloss meant to force inventors to focus on solving real-world problems.[66] Still others understand the categories to be particular expressions of other patent law doctrines, rather than independent limits. Natural phenomena and laws of nature are "inherently" present in nature and thus nonnovel,[67] while abstract ideas are ephemeral and thus incapable of being adequately disclosed.[68]

62. CHISUM ET AL., *supra* note 11, at 773. The Federal Circuit expressly stated that "the question of whether a claim encompasses statutory subject matter should not focus on *which* of the four categories of subject matter a claim is directed to . . . but rather on the essential characteristics of the subject matter, in particular, its practical utility." *State St.*, 149 F.3d at 1375.

63. MERGES & DUFFY, *supra* note 23, at 153–54.

64. *Chakrabarty*, 447 U.S. at 309; *see also* Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U.S. 127, 130 (1948) (holding claims unpatentable because the qualities claimed were "manifestations of laws of nature, free to all men and reserved exclusively to none"); O'Reilly v. Morse, 56 U.S. (15 How.) 61, 116 (1854) (finding Morse's claim for using electromagnetism to transfer intelligible signals directed at nonpatentable subject matter because "the discovery of a principle in natural philosophy or physical science, is not patentable").

65. *See* Gottschalk v. Benson, 409 U.S. 63, 67 (1972) ("Phenomena of nature, though just discovered, mental processes, and abstract intellectual concepts are not patentable, as they are the basic tools of scientific and technological work."); *Funk Bros.*, 333 U.S. at 130 ("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."); *see also* Peter Yun-hyoung Lee, *Inverting the Logic of Scientific Discovery: Applying Common Law Patentable Subject Matter Doctrine to Constrain Patents on Biotechnology Research Tools*, 19 HARV. J.L. & TECH. 79, 101 (2005).

66. *See* Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1642–43 (2003).

67. Dan L. Burk & Mark A. Lemley, *Inherency*, 47 WM. & MARY L. REV. 371, 408 (2005); *see also* Parker v. Flook, 437 U.S. 584, 593 n.15 (1978) ("The underlying notion is that a scientific principle, such as that expressed in respondent's algorithm, reveals a relationship that has always existed.").

68. Eileen M. Kane, *Patent Ineligibility: Maintaining a Scientific Public Domain*, 80 ST. JOHN'S L. REV. 519, 546 (2006).

The development of software code capable of running on general purpose computers only added to the judiciary's struggle to articulate a consistent approach. Software is distinguished from computer hardware in that it is essentially a set of instructions contained in a sequence of codes.[69] These instructions tell the physical hardware comprising the computer what to do, and the program runs as the computer follows its instructions.[70] For many years, the mathematical algorithm exception precluded the patenting of pure software code,[71] primarily because courts regarded algorithms as unpatentable "laws of nature"[72] or "abstract ideas."[73]

With a 5-4 decision in 1981, however, the Court began to blaze a theoretical path for those seeking to patent software-based inventions.[74] Writing for the majority, Justice Rehnquist found a process for curing rubber that incorporated a known mathematical formula called the Arrhenius equation to be patentable subject matter.[75] An otherwise patentable process,[76] he reasoned, was not unpatentable merely because it *used* a mathematical formula or algorithm.[77] Patent protection for a "formula in the abstract," however, remained unavailable under

69. *See* WILLIAM STALLINGS, COMPUTER ORGANIZATION & ARCHITECTURE: DESIGNING FOR PERFORMANCE 57 (7th ed. 2006) ("[I]nstead of rewiring the hardware for each new program, the programmer merely needs to supply a new set of control signals.").

70. *Id.* ("Each code is, in effect, an instruction, and part of the hardware interprets each instruction and generates control signals.").

71. *Cf.* MERGES & DUFFY, *supra* note 23, at 131; Burtis, *supra* note 22, at 1157 (discussing the difficulty of classifying the mathematical algorithms integral to computer software as either "inventions" or "abstract ideas" because they "may be used to describe both discovered and invented subject matter").

72. *See, e.g.*, *Flook*, 437 U.S. at 593–94 (defining the claimed mathematical algorithm as a law of nature).

73. *See, e.g.*, Gottschalk v. Benson, 409 U.S. 63, 71 (1972) ("It is conceded that one may not patent an *idea*. But in practical effect that would be the result if the formula for converting BCD numerals to pure binary numerals were patented in this case." (emphasis added)).

74. *See* Diamond v. Diehr, 450 U.S. 175, 192 (1981) (holding that the inclusion of a mathematical formula or algorithm in an otherwise patentable invention does not render the invention unpatentable).

75. *Id.* at 191–92.

76. A patentable process is one that "transform[s] or reduc[es] an article to a different state or thing." *Id.* at 192.

77. *Id.* The Court foreshadowed this reasoning three years earlier, stating that "a process is not unpatentable simply because it contains a law of nature or a mathematical algorithm." *Flook*, 437 U.S. at 590.

§ 101.[78] The Federal Circuit (drawing from the work of the Court of Customs and Patent Appeals) synthesized this reasoning into the formal *Freeman-Walter-Abele* test.[79] This test separated claims consisting wholly of unapplied mathematical algorithms from those containing algorithms in conjunction with otherwise statutory subject matter.[80]

Taking its cue from the Supreme Court, the Federal Circuit continued to expand the outer limits of subject matter jurisdiction. *In re Alappat* confirmed what two earlier Federal Circuit cases implied[81]—that a software program could be patented when characterized as a § 101 machine.[82] In effect, *In re Alappat* rendered any software program patentable, so long the inventor claimed the program in conjunction with a computer capable of running it.[83]

In 1998, the Federal Circuit further diminished subject matter patentability as a meaningful obstacle to software patentability. *State Street Bank & Trust Co. v. Signature Financial Group, Inc.* suggested, and a later case confirmed,[84] that patent applicants no longer needed to follow the formality of claiming software as a machine—any process, machine, manufacture, or composition of matter that "produce[d] a 'useful,

78. *Diehr*, 450 U.S. at 191. Even claims limiting application of a formula to a particular technology remained unpatentable, as did those that merely added insignificant post-solution activity to an algorithm. *Id.* at 192–93.

79. *See* Arrhythmia Research Tech., Inc. v. Corazonix Corp., 958 F.2d 1053, 1058 (Fed. Cir. 1992).

80. *Id.*

81. *See In re* Iwahashi, 888 F.2d 1370, 1375 (Fed. Cir. 1989) ("The fact that [the machine] operates according to an algorithm does not make it nonstatutory."); *In re* Bernhart, 417 F.2d 1395, 1400 (C.C.P.A. 1969) ("[I]f a machine is programmed in a certain new and unobvious way, it is physically different from the machine without that program.").

82. *See In re* Alappat, 33 F.3d 1526, 1545 (1994) (holding that reprogramming a general-purpose computer creates a new "machine" under § 101). The disputed claims covered a "rasterizer"—essentially a circuit board programmed to normalize data displayed on an oscilloscope screen, allowing the oscilloscope to display a smooth data curve line. *See id.* at 1537–39.

83. *Id.* at 1545 ("[A] general purpose computer in effect becomes a special purpose computer once it is programmed to perform particular functions pursuant to instruction from program software. . . . In any case, a computer, like a rasterizer, is [sic] apparatus not mathematics.").

84. AT&T Corp. v. Excel Commc'ns, Inc., 172 F.3d 1352, 1358–59 (Fed. Cir. 1999) (finding a *process* using a mathematical algorithm to automate differential billing of long-distance calls to be useful and therefore statutory subject matter). The scope of § 101 is "the same regardless of the form—machine or process—in which a particular claim is drafted." *Id.* at 1357.

concrete, and tangible result'" was patentable.[85] Furthermore, *State Street* explicitly disclaimed the *Freeman-Walter-Abele* test.[86] Any software invention that accomplished a useful result was now patentable.[87]

D. REVERSING THE TREND: RECENT CASE LAW REVITALIZES § 101

Despite the apparent breadth of § 101,[88] there are definite signs its scope may be narrowing. *In re Nuijten* found that a signal containing an improved digital watermark for audio files did not fall into any of the four categories and was therefore unpatentable.[89] *Nuijten* forcefully reasserted the independence of the subject matter test, narrowing *State Street* by holding a claim covering material outside the four categories unpatentable "even if the subject matter is otherwise new and useful."[90] Simply put, "[t]he four categories together describe the *exclusive* reach of patentable subject matter."[91] Although *In re Comiskey* echoed this theme,[92] the decision's real significance lay in its broader implications. First, the court restated the necessity of a first-in-time subject-matter test.[93] Second, the court again emphasized the four § 101 categories as real limits on patentability.[94] Third, the court affirmed common law limits on patent-

85. *Id.* (quoting *In re Alappat*, 33 F.3d at 1544).

86. *See* State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1374 (Fed. Cir. 1998).

87. *See id.* at 1373 ("Unpatentable mathematical algorithms are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that are not 'useful.'").

88. *See* CHISUM ET AL., *supra* note 11, at 775 (noting that courts have extended patentable subject matter to cover virtually all controversial subject matter they have confronted, including living organisms, computer programs, and business methods).

89. *In re* Nuijten, 500 F.3d 1346, 1357 (Fed. Cir. 2007).

90. *Id.* at 1354.

91. *Id.* (emphasis added).

92. *See In re* Comiskey, 499 F.3d 1365, 1377 (Fed. Cir. 2007) (finding claims unpatentable because "mental processes . . . standing alone are not patentable *even if they have a practical application*" (emphasis added)).

93. *See id.* at 1371 ("It is well established that '[t]he first door which must be opened on the difficult path to patentability is § 101.'" (quoting State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1372 n.2 (Fed. Cir. 1998))).

94. Two claims relating to "a method and system for mandatory arbitration involving legal documents, such as wills or contracts" recite unpatentable "mental steps" because they fail to "describe a process of manufacture or a process for the alteration of a composition of matter." *In re Comiskey*, 499 F.3d at 1379.

able subject matter—claims "directed to an abstract idea itself" are simply unpatentable.[95] Both of these decisions came on the heels of Supreme Court proceedings in which dissenting justices pointedly questioned the Federal Circuit's liberal application of § 101.[96] Furthermore, the five questions to be addressed by the Federal Circuit when it decides the pending case *In re Bilski* suggest that characterization of the four statutory categories as "merely representative" may have been premature.[97]

Faced with explosive growth in computer software, courts initially struggled to apply old doctrines of subject matter patentability to a new, less tangible form of technology. The dust momentarily settled, leaving software effectively patentable as long as it accomplished a useful result. Now, continuing technological innovation is forcing courts to once again reconsider the proper role of § 101. Indeed, commentators predict that the Supreme Court will revisit the proper scope of § 101 soon.[98]

II. ARTIFICIAL CREATIVITY EXPOSES PATENT LAW'S COSTLY IMPOTENCE

Emerging technologies such as genetic algorithms can be classified as both inventions and inventors. If the patent system is to remain viable, unpredictable abstract inventions such as artificial creative processes must be unpatentable. Of the patent law doctrines, subject matter patentability is best equipped to maintain the necessarily sharp distinction between

95. *Id.* at 1379–81.

96. The Court heard oral arguments for *Laboratory Corp. of America Holdings v. Metabolite Laboratories, Inc.* in 2006. *See* 546 U.S. 975 (2005) (granting petition for writ of certiorari). Justice Breyer dissented from the Court's subsequent dismissal of the writ as improvidently granted, noting that "[Federal Circuit precedent] does say that a process is patentable if it produces a 'useful, concrete, and tangible result.' But this Court has never made such a statement and, if taken literally, the statement would cover instances where this Court has held the contrary." Lab. Corp. of Am. Holdings v. Metabolite Labs., Inc., 548 U.S. 124, 136 (2006) (Breyer, J., dissenting) (citing *State St.*, 149 F.3d at 1373).

97. *See In re* Bilski, 264 F. App'x. 896, 897 (Fed. Cir. 2008) (ordering an en banc rehearing asking, among other questions, what standard governs a statutory "process" under § 101).

98. *See, e.g.*, Richard S. Gruner, *In Search of the Undiscovered Country: The Challenge of Describing Patentable Subject Matter*, 23 SANTA CLARA COMPUTER & HIGH TECH. L.J. 395, 400 (2007); Sue Ann Mota, *What Is Patentable Subject Matter? The Supreme Court Dismissed* LabCorp v. Metabolite Laboratories, *But the Issue Is Not Going Away*, 11 MARQ. INTELL. PROP. L. REV. 181, 185–92 (2007) (reviewing court decisions rendered during the LabCorp litigation).

inventor and invention. As currently applied, however, it is woefully inadequate.

A. CREATIVE SOFTWARE: PROPERLY UNPATENTABLE

What characterizes an "inventive process"? Simply put, an inventive process is anything that results in invention.[99] A technician employs pure logical reasoning,[100] whether performed mentally or with the aid of a computer program, to arrive at a useful but likely nonnovel or obvious solution. An artist, on the other hand, taps pure creativity to generate new ideas but lacks the logic necessary to determine which are useful. True invention occurs only when an inventor combines creativity with logic to obtain a solution that is useful, new, and not easily predictable.[101]

That is precisely what creative algorithms do. Take, for example, an electronic circuit. Traditionally, a human engineer must order various capacitors, inductors, and transistors into a specific circuit design. Then, a conventional software algorithm can enable an industrial assembly line robot to repeatedly assemble this specific circuit. John Koza's patented genetic algorithm, on the other hand, allows a software algorithm to actually *design* the circuit, rather than merely *replicate* it.[102] A genetic algorithm replaces the electrical engineer, autonomously choosing, ordering, and assigning strengths to various circuit components to achieve the predetermined circuit performance parameters.[103] Creative algorithms, like the mind, have the distinctly creative capacity to autonomously generate solutions that are both useful and unique.[104]

From the analysis above, it is clear that patents claiming algorithms capable of creative problem-solving effectively read

99. *Cf.* Vernon W. Ruttan, *Usher and Schumpeter on Invention, Innovation, and Technological Change*, 73 Q.J. ECON. 596, 600 (1959) (defining the act of inventing generally as any process requiring "an 'act of insight' going beyond the normal exercise of technical or professional skill").

100. Logical reasoning can be defined as "drawing inferences (*conclusions*) from some initial information (*premises*)." Kevin Emerson Collins, *Propertizing Thought*, 60 SMU L. REV. 317, 335 (2007).

101. "[A]t the end of the day, logical thinking is insufficient for invention and creativity." KOZA ET AL., *supra* note 2, at 11; *see also* KSR Int'l Co. v. Teleflex Inc., 127 S. Ct. 1727, 1740 (2007) ("If a person of ordinary skill can implement a predictable variation [of a prior invention or group of prior inventions], [obviousness under § 103] likely bars its patentability.").

102. *See* U.S. Patent No. 6,360,191 (filed Jan. 5, 1999).

103. *See id.* col. 52.

104. *See* Vertinsky & Rice, *supra* note 38, at 601.

on inventive processes. But what is wrong with such claims? Rationale supporting software patentability in general also applies to creative algorithms. Some argue that because the Framers created the patent system to protect the *most valuable* assets, patents should cover *any* invention that is economically valuable.[105] Furthermore, a technology-driven shift from tangible to intangible inventions has left intangible inventions with a social value at least as high as traditionally protected tangible inventions.[106] Finally, even if patentability should be limited to the technical arts, creative algorithms are certainly more technical in nature than business methods or medical procedures, both of which are currently patentable.[107]

Creative algorithms, however, involve an additional step—they blur the formerly bright line between the invention and the creative process that produced it.[108] Intuitively, it seems that a process emulating human creativity and intelligence simply should not be private property.[109] Unlike a heart, lung, or even a living cell, human creativity is not easily reduced to a biological mechanism. A creative algorithm seems to imitate human *consciousness* rather than *biology*. Acquiring private property rights in something so unique to and so universal among humans must give pause.

105. Erik S. Maurer, Note, *An Economic Justification for a Broad Interpretation of Patentable Subject Matter*, 95 NW. U. L. REV. 1057, 1058 (2001) ("[The] wealth-generating characteristics of innovation fundamentally justify a broad interpretation of patentable subject matter.").

106. *See* Gruner, *supra* note 22, at 359–60 (arguing for new patentable subject matter standards to accommodate intangible information processing advances that are "more and more the central features of new designs for products and processes that are highly useful").

107. *See* Thomas, *supra* note 4, at 1142 (arguing that patentable subject matter should be limited to "technology" because "technology presents a form of rational and systematic knowledge, oriented towards efficiency and capable of being assessed through objective criteria").

108. Before programmers developed creative algorithms, there was little risk of propertizing the inventive process because pure "mental steps" cannot be patented. *See In re* Comiskey, 499 F.3d 1365, 1377–78 (Fed. Cir. 2007) ("[M]ental processes—or processes of human thinking—standing alone are not patentable even if they have practical application.").

109. Similar intuitive objections have been raised to DNA sequence patents and patents covering biological life forms. *See, e.g.*, Linda J. Demaine & Aaron Xavier Fellmeth, *Reinventing the Double Helix: A Novel and Nonobvious Reconceptualization of the Biotechnology Patent*, 55 STAN. L. REV. 303, 435 (2002) (discussing fears that granting private property rights in naturally occurring human DNA sequences, tissues, or biochemicals is akin to slavery, in that it prevents other individuals from commercializing such substances naturally existing in their own bodies).

The prospect of patenting artificial creativity also raises substantial practical concerns—indeed, practical concerns sufficient to obviate reliance on moral intuition. Extending patent protection to creative processes is inconsistent with basic patent law philosophy, renders patent scope ambiguous and infringing activity difficult to detect, and threatens to chill future invention.

Patent protection for any invention ultimately must comport with basic philosophies underlying the patent system. The American patent system is based primarily on utilitarianism[110] and secondarily on John Locke's theory of labor.[111] The inherently broad scope of a patent covering an inventive process renders its patentability suspect under Locke's labor theory. By exploiting an automated inventive process to solve a wide variety of problems, the inventor could gain an economic reward out of proportion to the amount of labor he invested in creating his inventive process. Under traditional utilitarian theory, granting patent protection would certainly serve both as a stimulus for further development of creative algorithms and as a mechanism for forcing their public disclosure. Patent protection, however, is not the *only* way to achieve these ends.[112] Other forms of intellectual property protection, such as copyright and trade secret, remain available to creative software. Furthermore, because of the tremendous commercial potential of artificial creative processes, the competitive advantage from being the first mover may alone be sufficient incentive.[113] Public disclosure, on the other hand, might be achieved in the same manner as basic scientific research—through publication in trade journals.[114]

110. *See supra* note 12 and accompanying text.

111. *See* Adam Mossoff, *Rethinking the Development of Patents: An Intellectual History, 1550–1800*, 52 HASTINGS L.J. 1255, 1315 (2001) (contending that Locke's labor theory of property contributed significantly to the growth and development of patent law).

112. *Cf.* Samuelson, *supra* note 32, at 1148 ("[I]nnovation in the software field has developed rapidly without the aid of patents.").

113. While the average amount of time that a first mover enjoys an effective monopoly has steadily declined, it remains significant, and the absolute size of sales per unit time of the effective monopoly is increasing. *See* Rajshree Agarwal & Michael Gort, *First-Mover Advantage and the Speed of Competitive Entry, 1887–1986*, 44 J.L. & ECON. 161, 173 (2001).

114. *See* Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 79–80 (1999) (proposing to stimulate invention "not through stronger intellectual property rights, but through norms that militate *against* the securing of such rights"); *see also* ROBERT K. MERTON, THE SOCIOLOGY OF SCIENCE 273–75 (1973) (de-

Artificial inventors present related practical difficulties in determining patent scope and enforcing infringement. Does a patented inventive process or machine inventor cover only the *process*, or does it also cover the *products*?[115] In either case, enforcing the right to exclude becomes an exercise in futility. Suppose, for example, Designer *A*, the holder of a patented genetic algorithm capable of designing circuits,[116] brought an infringement action against Designer *B*. He alleges that Designer *B* used his patented process for inventing circuits. Because of the unpredictable nature of genetic algorithm function, it would be effectively impossible to prove that Designer *B*'s circuit resulted from use of Designer *A*'s inventive process. Even if Designer *A* could prove that Designer *B* used the patented inventive process to design circuits generally, because genetic algorithms do not produce the same result twice he would find it difficult to prove that Designer *B* used his program to design *this* circuit.

Finally, there is a strong risk that granting monopoly rights over such "broad areas of problem solving" will chill future invention.[117] The tools of science used to invent exist on a continuum, from basic "upstream knowledge" such as the relationship between force and mass to downstream applied knowledge in the form of an invention such as the microscope.[118] To achieve the proper balance between enabling and stimulating invention, patent law must limit the scope of patentable subject matter to downstream research tools.[119] The idea-expression di-

monstrating a robust communalism among the scientific community that encourages the sharing of research results).

115. *See* Vertinsky & Rice, *supra* note 38, at 601 (making this distinction between the *process* of artificial invention and the *products* of the process).

116. *See, e.g.*, U.S. Patent No. 6,360,191 abstract (filed Jan. 5, 1999) (describing "[a]n automated design process and apparatus for use in designing complex structures, such as circuits, to satisfy prespecified design goals, using genetic operations").

117. *See* Vertinsky & Rice, *supra* note 38, at 601.

118. *See* Peter Lee, Note, *Patents, Paradigm Shifts, and Progress in Biomedical Science*, 114 YALE L.J. 659, 663 n.10 (2004) (defining basic research as "upstream research aimed at elucidating the fundamental structure and properties of natural phenomena," and applied research as "downstream testing and experimental work that applies basic knowledge to solve practical problems").

119. Limiting the control an inventor has over the "derivative works" enables "subsequent innovators to work out new implementations." Burk & Lemley, *supra* note 66, at 1642–43; *see also* Rai, *supra* note 114, at 80 ("[T]hose scientific research norms that have been most resistant to [broadened intellectual property rights] are more likely to achieve creation, disclo-

chotomy present in copyright law illustrates the necessity of maintaining fundamental knowledge in the public domain. Just as one cannot copyright specific words of the English language because those words are necessary to allow others to create expressive works, one should not be able to patent creative processes that are essential to continued invention.[120]

Problem-solving creative algorithms are inherently broad upstream tools. Even patent claims limited to a specific application may be couched in sufficiently expansive language to nonetheless cover all possible uses of a certain inventive process.[121] Because of their ability to quickly and cheaply create useful downstream products, inventive processes will be responsible for an increasing percentage of society's inventions.[122] Future inventors would be forced to clear not only the *results* of their invention against prior art, but also their problem-solving *methods*.

Such broad patent coverage also evokes the "tragedy of the anticommons," a theory recognizing the potential for broad exclusionary rights to generate detrimental underuse of a resource (here, creative processes).[123] Allowing the privatization of artificial inventive processes[124] may give rise to a paralyzing anticommons where the transaction costs of licensing artificial inventive processes deter others from using them.[125] The upstream nature of inventive processes only exacerbates the risk of an anticommons by widening the scope of invention that patent owners may exclude.

sure, and development than full-blown intellectual property rights."); Yun-hyoung Lee, *supra* note 65, at 82 (contending that patents on basic scientific tools "disrupt the balance between freely available basic knowledge and privatized applied knowledge that is crucial to driving innovation").

120. *See* Yun-hyoung Lee, *supra* note 65, at 99–100.

121. For instance, the phrase "creating a structural design that satisfies prespecified design goals" may suggest the claim is limited to a specific application, but it is unlikely that genetic algorithms have any applications other than creating designs that satisfy prespecified design goals. *See* U.S. Patent No. 6,360,191 claim 1 (filed Jan. 5, 1999).

122. *See* Vertinsky & Rice, *supra* note 38, at 578–81 (outlining the economic advantages of artificial inventors).

123. *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 623–24 (1998).

124. *See, e.g.*, U.S. Patent No. 6,360,191 (filed Jan. 5, 1999) (granting a private exclusionary right to inventor John Koza covering a genetic algorithm by claiming the algorithm as computer software).

125. Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698 (1998).

This is not to say that artificial creative processes lack social value. They have tremendous potential to significantly decrease the cost and increase the volume of invention, resulting in increased economic efficiency.[126] Furthermore, artificial inventors eliminate human fatigue and human error from the inventive process while retaining human-like creativity.[127] The above analysis shows, however, that the costs of *patenting* such processes are high. In the absence of evidence that patent protection is necessary to stimulate development of creative algorithm technology,[128] the heavy cost of allowing monopolization of an inventive process outweighs any benefit to be gained.

B. CURRENT SUBJECT-MATTER DOCTRINE: NEEDED BUT WEAK

The prospect of artificial creativity confronts the patent regime with fundamental challenges. Several commentators contend that trying to limit patent scope through § 101 leads to arbitrary boundaries easily circumvented with "magic words" in the claim language.[129] The scope of patents, they argue, can be adequately and more effectively limited using other doctrines such as novelty, nonobviousness, and the disclosure requirements of § 112.[130] Each of the required elements of patentability (utility, novelty, nonobviousness, and adequate disclosure), however, is inherently individual.[131] As such, these doctrines permit analysis of inventions claiming inventive processes only on a case-by-case basis. The doctrine of patentable subject matter, on the other hand, acts as patent law's gatekeeper[132] and directly addresses the *type* of inventions eligi-

126. *See* Vertinsky & Rice, *supra* note 38, at 578–79.

127. *See id.* at 578.

128. Two factors combine to predict rapid development of creative algorithm technology in the absence of patent protection. First, conventional software developed rapidly even before courts were willing to grant it patent protection. Second, autonomous artificial invention offers design firms who develop the technology potentially enormous cost savings in research and development.

129. *E.g.*, Cohen & Lemley, *supra* note 34, at 9 (noting that throughout the 1980s and early 1990s, when software itself was unpatentable, inventors could easily circumvent this barrier by claiming software inventions as the hardware "machines" they controlled).

130. *See, e.g.*, Kristen Osenga, *Ants, Elephant Guns, and Statutory Subject Matter*, 39 ARIZ. ST. L.J. 1087, 1091–92 (2007); Brief of Amicus Curiae American Intellectual Property Law Association, in Support of Appellants for Hearing En Banc at 10–13, *In re* Bilski, No. 2007-1130 (Fed. Cir. Mar. 6, 2008).

131. *See* MARK A. LEMLEY ET AL., SOFTWARE AND INTERNET LAW 180 (2006).

132. *See* Parker v. Flook, 437 U.S. 584, 593 (1978) ("The obligation to de-

ble for patent protection.[133] Subject-matter doctrine is therefore better suited to categorically address the broader issues raised by highly abstract inventions.

1. A Robust Patentable Subject-Matter Doctrine: Necessary Now More than Ever

Although major battles over patentable subject matter may appear over,[134] § 101 continues to perform two necessary functions—first, checking the volume of patent applications, and second, excluding subject matter that society has determined too costly to protect.

As technological development accelerates, the volume of invention will continue to increase proportionately. Indeed, over the last ten years the number of utility patents granted per year has increased almost 50%.[135] The number of patent applications grew even more rapidly—increasing 60% from 1986 to 1996[136] and 120% from 1996 to 2006.[137] A well-defined and strictly enforced subject-matter doctrine would increase patent examiner efficiency by allowing quick rejections for applications claiming clearly unpatentable subject matter. It would also decrease the number of patent applications filed in

termine what type of discovery is sought to be patented must precede the determination of whether that discovery is, in fact, new or obvious."); *see also In re* Comiskey, 499 F.3d 1365, 1371 (Fed. Cir. 2007); *In re* Bergy, 596 F.2d 952, 960 (C.C.P.A. 1979) ("The first door which must be opened on the difficult path to patentability is § 101 . . . .").

133. CHISUM ET AL., *supra* note 11, at 772.

134. Although software and biotechnology-based inventions were originally considered to be at least on the fringe of patentable subject matter, if not beyond the realm thereof, two cases appear to have placed them securely within patentable subject matter. *See* Diamond v. Chakrabarty, 447 U.S. 303 (1980) (finding genetically engineered microorganisms to be patentable subject matter); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368 (Fed. Cir. 1998) (implying that software programs claimed as processes alone are patentable subject matter); *see also* Cohen & Lemley, *supra* note 34, at 4 ("With some eighty thousand software patents already issued, the Federal Circuit endorsing patentability without qualification, and the Supreme Court assiduously avoiding the question, software patentability [under § 101] is a matter for the history books.").

135. The USPTO granted 61,104 patents in 1996 and 89,823 patents in 2006. U.S. PATENT & TRADEMARK OFFICE, ALL TECHNOLOGIES REPORT A1-1 (2008), http://www.uspto.gov/go/taf/all_tech.pdf.

136. U.S. PATENT & TRADEMARK OFFICE, NUMBER OF UTILITY PATENT APPLICATIONS FILED IN THE UNITED STATES, BY COUNTRY OF ORIGIN CALENDAR YEAR 1965 TO PRESENT (2007), http://www.uspto.gov/go/taf/appl_yr.pdf.

137. The USPTO received 195,187 patent applications in 1996 compared with 425,967 in 2006. *Id.*

the first place by giving inventors in certain fields ex ante knowledge that their inventions are unpatentable. Society would thus benefit by averting (presumably) wasteful and unproductive investment in efforts to obtain patent protection.

Subject-matter doctrine also enables society to impose targeted checks on the growth of intellectual property rights.[138] Congress has acted, albeit infrequently, to render patents on particularly objectionable types of invention unenforceable and, therefore, effectively unpatentable.[139] A strong subject-matter doctrine also offers a psychological advantage. To some researchers and inventors, economic incentives may be secondary to the pursuit of personal achievement and recognition.[140] Invoking the subject matter patentability doctrine allows society to avoid the cost of private monopolies on certain inventions without denying or degrading their utility. The researcher or inventor thus retains the psychological reward of social recognition for his useful and innovative, though unpatentable, invention or discovery.[141]

2. Current Subject-Matter Doctrine: Almost Anything Goes

State Street reiterates the common theme that a patentable invention must have a "practical application."[142] However, it defines practical application in a manner that bends analytical focus from the *nature* of the subject matter sought to be patented towards its *result*.[143] Indeed, under *State Street*, the sub-

138. If, for instance, society were to come to a consensus that genetic sequences should not be private property, a heightened utility requirement would likely be insufficient to exclude *all* genetic sequence patents. A much more effective route would be for Congress to exercise its constitutional discretion to "promote the Progress of Science and useful Arts," U.S. CONST. art. I, § 8, cl. 8, by using targeted legislation to simply prohibit the patenting of genetic sequences.

139. *See* 35 U.S.C. § 287(c)(1) (2000) (limiting enforcement of medical procedure patents against doctors and other health providers); *see also* MERGES & DUFFY, *supra* note 23, at 184–85.

140. *See* Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177, 183 (1987) ("The scientific community rewards those who make original contributions to the common stock of knowledge by giving them professional recognition.").

141. *See* Robert P. Merges, *Property Rights Theory and the Commons: The Case of Scientific Research*, 13 SOC. PHIL. & POL'Y 145, 150 (1996).

142. State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1373 (Fed. Cir. 1998).

143. *See id.* (noting that claimed subject matter "constitutes a practical application of a mathematical algorithm, formula, or calculation, *because* it produces 'a useful, concrete and tangible result'" (emphasis added)).

ject matter test is virtually indistinguishable from the separate utility test.[144]

a. Creative Algorithms Are Patentable Under the Common Law

Under *State Street*, the common law categories have little independent force—any abstract idea that accomplishes a "useful, concrete, and tangible result" is patentable.[145] Furthermore, the result accomplished need not be "concrete and tangible" in the *physical* sense—the "transformation of data . . . through a series of mathematical calculations into a final share price" is sufficient.[146] An abstract idea is no longer per se unpatentable—it is unpatentable only when it *also* fails to accomplish a "useful, concrete, and tangible result."[147] With the judicial test so constructed, the common law categories are only of minor relevance to creative algorithms. Certainly a genetic algorithm that designs a working circuit achieves a "useful, concrete, and tangible result." Moreover, the utility standard under patent law is a "minimal one."[148] Under current patent law, common law categories of unpatentable subject matter have lost much substantive force. Either they must be given new life or limits on the patentability of creative algorithms must be found elsewhere.

144. *See id.* ("Unpatentable mathematical algorithms are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that are not 'useful.'"); *see also* Thomas, *supra* note 4, at 1160 (noting that *State Street* "collapses the subject matter inquiry into another patentability requisite, that of utility").

145. *See State St.*, 149 F.3d at 1373.

146. *Id.*; *see also* AT&T Corp. v. Excel Commc'ns, Inc., 172 F.3d 1352, 1358 (Fed. Cir. 1999) ("The notion of 'physical transformation' can be misunderstood. . . . [I]t is not an invariable requirement, but merely one example of how a mathematical algorithm may bring about a useful application.").

147. *See AT&T Corp.*, 172 F.3d at 1361 (noting the proper focus of inquiry is "whether the algorithm-containing invention, as a whole, produces a tangible, useful, result"). *In re Comiskey* qualifies this statement, stating that "mental processes . . . standing alone are not patentable even if they have practical application." 499 F.3d 1365, 1377 (Fed. Cir. 2007). However, other abstract processes with practical applications—mathematical algorithms, for example—likely remain patentable under *State Street*'s logic.

148. Thomas, *supra* note 4, at 1160.

b. Creative Algorithms Are "Processes" or "Machines" Under § 101

State Street's present effect on § 101 categories is less clear. *State Street* pays them lip service,[149] but quickly sidelines any substantive analysis in favor of a utility inquiry.[150] Apparently regretting its broad language in *State Street*, however, the Federal Circuit recently clarified that the four § 101 categories continue to define the limits of patentable subject matter and should not be collapsed into a utility test.[151]

Creative algorithms, for the purposes of § 101's four positive categories, are indistinguishable from conventional software algorithms. Software algorithms, as discussed above, need not produce any physical transformation to be patentable processes.[152] Creative algorithms remain, at their core, software algorithms and are likely satisfy the § 101 definition of a process.[153] Furthermore, in light of the Federal Circuit's decision in *In re Alappat*, creative algorithms claimed as computer-implemented processes[154] likely qualify as statutory machines.[155] Under current law, algorithms with creative capacity

149. *See State St.*, 149 F.3d at 1372 ("The plain and unambiguous meaning of § 101 is that any invention falling within one of the four stated categories of statutory subject matter may be patented . . . ."). Indeed, *State Street* appears to restore a "process" under § 101 to its full literal scope, undoing *Gottschalk v. Benson*'s exclusion of subject matter that was technically a "process." *See* 409 U.S. 63, 71 (1972) (denying that a process for converting one form of a number into another form was a "process" under § 101).

150. *State St.*, 149 F.3d at 1375 ("The question of whether a claim encompasses statutory subject matter should not focus on *which* of the four categories of subject matter a claim is directed to—process, machine, manufacture, or composition of matter—but rather on the essential characteristics of the subject matter, in particular, its practical utility." (footnote omitted)).

151. *See, e.g.*, *In re* Nuijten, 500 F.3d 1346, 1354 (Fed. Cir. 2007) ("[W]e do not consider [*State Street*] as holding that the four statutory categories are rendered irrelevant, non-limiting, or subsumed into an overarching question about patentable utility.").

152. *See AT&T Corp.*, 172 F.3d at 1358 (noting that a physical transformation is merely "one example of how a mathematical algorithm may bring about a useful application").

153. A patentable "process" is "'an act, or a series of acts, performed upon the subject-matter to be transformed and reduced to a different state or thing.'" Gottschalk v. Benson, 409 U.S. 63, 70 (1972) (quoting Cochrane v. Deener, 94 U.S. 780, 787–88 (1876)).

154. *See, e.g.*, U.S. Patent No. 6,360,191 (filed Jan. 5, 1999) (claiming a genetic algorithm as such).

155. *See* 33 F.3d 1526, 1536 (Fed. Cir. 1994). Although the Federal Circuit later recognized that claiming software as a "machine" was not necessary, it certainly remains sufficient. *See AT&T Corp.*, 172 F.3d at 1358–59.

likely qualify under § 101 as a process, if claimed alone, or as a machine, if claimed in conjunction with a computer.

If a patent attorney drafts claims covering creative algorithms just as she drafts conventional software patent claims, the inventive processes creative algorithms are likely patentable under both common and statutory law. Unless the subject-matter doctrine can be cured of its current impotence, patent law will continue to slide towards a detrimental conflation of inventor and invention.

III. STEELING THE GATEKEEPER: IDENTIFYING WORKABLE BOUNDARIES FOR PATENTABLE SUBJECT MATTER UNDER § 101

Algorithms enabling artificial creativity are illustrative of the types of boundary-blurring,[156] abstract inventions that will continue to challenge the key assumption underlying patent law theory—that patenting a particular invention will have the net effect of stimulating, rather than chilling, further invention. Patent law must recognize and enforce an interpretation of § 101 supporting this assumption. Because a creative process[157] is inherently broad and unbounded, a patent covering such a process is inconsistent with this assumption. Section 101 is fully capable of separating such abstract processes from those that are consistent with the goal of stimulating invention, but only if courts change how they *apply* it. First, common law subject-matter doctrine must be independently rooted in a single theoretical basis. Second, statutory categories must exclude from "processes" or "machines" those inventions whose use generates inherently unpredictable products.

156. The Supreme Court adheres to the mantra that "anything under the sun made *by man*" is patentable. Diamond v. Diehr, 450 U.S. 175, 182 (1981) (citation omitted) (emphasis added). This phrase misfocuses the patentability inquiry on *who* made the invention rather than on the *nature* of the invention itself. By assuming that the inventive process ends once something is "made by man," the Court ignores the possibility that man could create an invention that itself is capable of creative invention.

157. This Note does not directly address the issue of whether the products of creative algorithms should be patentable. For discussion of a related issue, copyright protection for computer-generated creative works, see generally Arthur R. Miller, *Copyright Protection for Computer Programs, Databases, and Computer-Generated Works: Is Anything New Since CONTU?*, 106 HARV. L. REV. 977, 1042–72 (1993); Samuelson, *supra* note 32, at 1142–53.

A. Common Law Doctrine: Focusing on Access to Basic Scientific Tools

Both Supreme Court precedent[158] and pragmatic concerns demand that subject matter patentability remain a robust, independent hurdle. By essentially equating subject-matter doctrine with the utility test, *State Street* renders it largely inconsequential. Several mechanisms for narrowing the scope of *State Street*, as it applies to patentable subject matter generally, have been suggested.[159] The two reconceptualizations suggested here, however, are specifically tailored to restore to the common law categories their proper independent force. The common law categories can be resurrected by first, recognizing their independence from explicit statutory categories under § 101 and second, applying them solely as means to preserve access to the basic tools of science, rather than ends themselves.

1. Common Law Unpatentability: Independent of Statutory Patentability

The Supreme Court has consistently but needlessly conflated two distinct concepts—the inclusive statutory definition of patentable subject matter and the exclusive common law definition.[160] Clearly, subject matter not a § 101 process, machine, manufacture, or composition of matter cannot be patented. There is no need, however, to merge the exclusive common law doctrine into the definition of these terms.[161] By maintaining

158. *See, e.g.*, Parker v. Flook, 437 U.S. 584, 593 (1978) ("The obligation to determine what type of discovery is sought to be patented must precede the determination of whether that discovery is, in fact, new or obvious.").

159. *See, e.g.*, Thomas, *supra* note 4, at 1143 (suggesting that patentability can be limited to the technological arts by requiring subject matter to have an "industrial application" and by restricting patentable inventions to "repeatable production or transformation of material objects").

160. *See, e.g.*, *Flook*, 437 U.S. at 589–90, 595 (reasoning that the formula for computing an alarm limit was a natural law, therefore it was already known, and therefore the claimed invention was not a statutory "process"); Gottschalk v. Benson, 409 U.S. 63, 64, 68 (1972) (stating first that "[t]he question is whether the method described and claimed is a 'process' within the meaning of the Patent Act," and proceeding to determine that it was not because the algorithm for converting a binary coded decimal to a pure binary number was merely an abstract concept).

161. Certainly, common law cannot override statute. Because the language of § 101 states unequivocally that *any* "process, machine, manufacture, or composition of matter" is patentable subject matter, in the strictest sense, an unpatentable abstract idea, natural law, or natural phenomena cannot be a § 101 "process." *See* 35 U.S.C. § 101 (2000). Law exists as *applied* theory, how-

common law unpatentability as an independent and external doctrine, courts would obviate the need to artificially limit definitions of positive § 101 categories.[162] Judges could then focus, clear-headed, on two separate inquiries. First, the exclusive analysis—whether common law disqualifies the subject matter as an abstract idea, law of nature or natural phenomena. If not, then the inclusive analysis—whether the subject matter qualifies under § 101 as a "process, machine, manufacture, or composition of matter." By conducting two independent analyses, courts would avoid the conceptual mess inherent in efforts to define "processes" so as to exclude abstract ideas, laws of nature, and natural phenomena.

2. The Common Law Categories: Means To Protect the Basic Tools of Science and Nothing More

Imprecision and "lawyerly word games"[163] have consistently handicapped courts' analyses of patentable subject matter under the common law. *State Street* understood the law governing patentable subject matter simply as an extra mechanism to ensure the invention was useful. Decisions preceding *State Street* cited various alternative justifications, including lack of novelty because the subject matter was inherent in nature,[164] the need to keep basic scientific tools accessible,[165] and in a brief fit of circular reasoning, the categories themselves.[166] To

ever, and it makes little sense to analyze whether a claimed set of steps for converting light and carbon dioxide into sugar through photosynthesis is a "process" only to find it is not because it is a natural phenomena. Instead, for the sake of analytical clarity, courts should find photosynthesis unpatentable because it is a natural phenomenon, thereby reserving analysis of whether claimed steps are a "process" for subject matter that is not clearly an abstract idea, law of nature, or natural phenomena.

162. *See, e.g.*, *Benson*, 409 U.S. at 64–65, 68, 70 (defining a patentable process as the "[t]ransformation and reduction of an article 'to a different state or thing'" and then proceeding to determine that "programs to solve mathematical problems of converting one form of numerical representation to another" are not such "processes").

163. *See* Burk & Lemley, *supra* note 67, at 403.

164. *See, e.g.*, Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U.S. 127, 130 (1948) (finding a mixture of nitrogen-fixing bacteria unpatentable because the bacteria were claimed in their natural state—nothing was invented); O'Reilly v. Morse, 56 U.S. (15 How.) 61, 132 (1854) ("The mere discovery of a new element, or law, or principle of nature without any valuable application of it to the arts, is not the subject of a patent.").

165. *See, e.g.*, *Benson*, 409 U.S. at 67.

166. *See, e.g.*, Le Roy v. Tatham, 55 U.S. (14 How.) 155, 175 (1852) ("[A] principle is not patentable. A principle, in the abstract, is a fundamental truth; an original cause; a motive; these cannot be patented, as no one can

be effective, the doctrine must be focused. Common law limits on patentability can effectively screen out inventors and inventive processes only when courts apply "laws of nature, physical phenomena, and abstract ideas"[167] as nothing more than analytical means to achieve a single and specific end: maintaining public access to the basic tools of science.

The Constitution explicitly states that patent law exists to "promote the Progress of Science and useful Arts."[168] A common law inquiry focused on maintaining access to scientific tools directly reflects this purpose. It also forces subject matter patentability doctrine to reflect patent law's broad grounding in utilitarianism—freely available scientific tools promote and encourage "useful and beneficial innovation"[169] by reducing the costs of research.[170] Focusing analyses on the extent to which patents increase the cost of using basic scientific tools compels courts to confront squarely the risk of fostering an anticommons.[171]

Because most inventions can be used for scientific purposes, determining which inventions qualify as "basic tools of scientific research" requires striking a delicate balance between access and incentive. Courts and policymakers, then, must determine which tools are sufficiently basic to justify denying the patent privilege.[172] To achieve this end, courts must use the

claim in either of them an exclusive right.").

167. Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980).

168. U.S. CONST. art. I, § 8, cl. 8.

169. *See* Jonathan Kahn, *What's the Use? Law and Authority in Patenting Human Genetic Material*, 14 STAN. L. & POL'Y REV. 417, 435 (2003) ("The underlying rationale of patent law is to serve the public good by creating legal protections to promote useful and beneficial innovation.").

170. As discussed above, privatization of a resource necessary to enable future invention (here "inventive processes") raises the costs for others seeking to use that resource, thus chilling the innovation that depends on its use. *See* Heller & Eisenberg, *supra* note 125, at 698.

171. *See id.* (noting that as more private parties acquire exclusionary rights in a resource, the risk that it will be underexploited increases).

172. *But see* SmithKline Beecham Corp. v. Apotex Corp., 365 F.3d 1306, 1316 (Fed. Cir. 2004), *vacated on reh'g en banc*, 403 F.3d 1328 (Fed. Cir. 2005), *superseded*, 403 F.3d 1331 (Fed. Cir. 2005) (stating that patentable subject matter and the scope of claims are unrelated); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1377 (Fed. Cir. 1998) (asserting that the scope of patent claims should be limited by §§ 102, 103, and 112, not by § 101). Section 101, however, addresses subject matter whose nature is such that *any* claim covering that subject matter would be impermissibly broad. That is, the inquiry focuses on the inherent scope of the subject matter claimed, rather than the scope of the specific claim language. *See* 35 U.S.C. § 101 (2000).

conceptual categories of abstract ideas, laws of nature, and natural phenomena as lenses through which to focus analyses.

Because each of these categories comprises subject matter essential to continuing research and development,[173] a claimed invention falling wholly within any category or any combination of the three is definitively unpatentable. The categories are merely analytical means, however, and as such they do not define the full reach of the common law exclusions. Subject matter not explicitly within the three categories but closely analogous and implicating similar concerns may yet be sufficiently basic for the common law to render it unpatentable. Thus, abstract ideas, laws of nature, and natural phenomena are sufficient, though not necessarily exclusive, components of the common law inquiry.[174] By using the common law categories as means to identify and deny patent protection to basic scientific tools, courts can give common law patentability doctrine sufficient independent vitality to confront artificial creativity and other similarly broad abstract inventions.

Grounding common law unpatentability in other patent law doctrines such as utility and novelty is problematic. *State Street*'s "useful, concrete and tangible result" test ignores the very real possibility of highly useful yet preferably unpatentable inventions. Nonnovelty, or preemption by nature's "prior art,"[175] is similarly deficient in at least three ways.[176]

First, a common law doctrine grounded in nonnovelty renders subject matter unpatentable only when it is discovered rather than created. Although abstract ideas such as mathematical algorithms model the logic of the universe with impres-

173. *See supra* notes 64–65 and accompanying text.

174. Other suggested mechanisms provide useful complements in the difficult task of identifying sufficiently "basic" scientific tools. *See, e.g.*, Yunhyoung Lee, *supra* note 65, at 82 (discussing "upstream" versus "downstream" research tools); *cf.* Rai, *supra* note 114, at 138–40 (proposing various strategies for using the law to reinforce scientific research norms that support maintaining a large public domain of biotechnology research tools). Other policy discussions center on, for instance, whether the "scientific model of research" or the "market model of innovation" is superior. *See* Kahn, *supra* note 169, at 438–39.

175. Burk and Lemley suggest an "inherency" doctrine that renders unpatentable *unchanged* natural products. *See* Burk & Lemley, *supra* note 67, at 408. This formulation, however, is ill-suited to limit creative algorithms.

176. *But see* Burtis, *supra* note 22, at 1157 (emphasizing the importance of distinguishing between that which is discovered and invented to accurately interpret § 101, and noting courts' continued difficulty in recognizing the distinction).

sive success, they may in fact be merely useful human constructs.[177] The same may be said of natural laws, such as the theory of natural selection. The definition of "basic scientific tools," on the other hand, does not depend on whether the tools are "created or discovered"—they may be both. Second, all inventions are to some degree a "manifestation of natural materials and natural laws."[178] It is exceedingly difficult to delineate precisely how much human manipulation is necessary before the invention is sufficiently artificial, a fact the Supreme Court has recognized.[179] Although determining whether certain tools of science are sufficiently basic also requires significant judgment, courts can support such judgments with empirical data.[180] Third, the nature of human thought is incredibly complex. Even if creative algorithms appear to share many parallels with natural laws governing human logic and creativity, neuroscientists have not yet uncovered the precise mechanisms that govern the mind.[181] Common law doctrine is most effective, then, when the inquiry focuses solely on the extent to which claimed subject matter would monopolize basic scientific tools.

3. Applying the Common Law Categories: An Inventive Process Is a Basic Tool of Science

Creative algorithms potentially propertize basic scientific tools on two levels—as mathematical algorithms and as inventive processes. Determining the extent to which claims covering mathematical algorithms preclude others from using them, however, is a task that has consistently confounded courts.[182]

177. *See* Burk & Lemley, *supra* note 67, at 408; Samuelson, *supra* note 32, at 1097 n.274 ("It quite obviously makes no sense to make the patentability of mathematical formulae turn on whether they are 'invented' or 'discovered,' for it is impossible to know for certain which is the case.").

178. Burk & Lemley, *supra* note 67, at 406–07.

179. *See* Diamond v. Diehr, 450 U.S. 175, 189 n.12 (1981) (cautioning against a reductionist argument which would "if carried to its extreme, make all inventions unpatentable because all inventions can be reduced to underlying principles of nature which, once known, make their implementation obvious").

180. For instance, courts could cite economic data showing the projected cost of licensing a tool should it become patented or statistical data showing current or projected usage rates of the tool at issue in a particular research field.

181. *But see* Allen Newell, *Response: The Models Are Broken, The Models Are Broken!*, 47 U. PITT. L. REV. 1023, 1025 (1986) ("[H]umans think by means of algorithms. Sequences of mental steps and algorithms are the same thing.").

182. *Compare* Gottschalk v. Benson, 409 U.S. 63, 72 (1972) (finding that

The only plausible line that may be drawn is the one that courts have adhered to: an unapplied, "disembodied mathematical concept" remains unpatentable.[183] Once algorithms are put to use as computer software, delineating between those that propertize basic tools of science and those that do not becomes much more difficult.[184] The component algorithms of creative processes such as genetic algorithms, viewed in isolation, differ little from those of traditional software.[185] Thus, it is similarly futile to analyze the patentability of creative processes in terms of their component algorithms. Creative algorithms emerge as fundamentally different only when one takes a step back and analyzes them in terms of the functionality they enable—artificial creativity.

Unlike mathematical algorithms, inventive processes do not fit neatly into any of the three common law categories—laws of nature, natural phenomena, or abstract ideas. As discussed above, however, the common law categories are best applied only as means to identify the basic tools of science. An inventive process is broadly abstract. Although the final invention is often quite concrete, the inventive *process* requires a freeform, unpredictable combination of logic and creativity. Furthermore, inventive processes do not merely apply existing scientific knowledge[186]—they also create new basic knowledge. A genetic algorithm, for instance, may evolve a unique combination of circuit components previously thought to be unworka-

the claimed mathematical algorithm had *only* the claimed use, and thus "the patent would wholly pre-empt the mathematical formula"), *with* AT&T Corp. v. Excel Commc'ns, Inc., 172 F.3d 1352, 1358, 1360 (Fed. Cir. 1999) (explaining that applying a mathematical algorithm "in a practical manner to produce a useful result" is sufficient to show that the patent applicant has not "attempt[ed] to forestall its use in any other application").

183. *See AT&T Corp.*, 172 F.3d at 1357. For instance, the Pythagorean Theorem, $a^2 + b^2 = c^2$, is by itself unpatentable.

184. The "mathematical algorithm" exception was at least in part based on the idea that pure mathematical algorithms are abstract ideas, and the Supreme Court has not held a patent invalid because it claimed an "abstract concept" since *O'Reilly v. Morse*. *See* 56 U.S. (15 How.) 61, 112−21 (1853); *see also* Burk & Lemley, *supra* note 67, at 403−04.

185. *See* KOZA ET AL., *supra* note 2, at 77 ("The computer programs involved in genetic programming may be single-branch programs . . . or multi-branch programs (containing one or more result-producing branches, automatically defined functions, automatically defined iterations, automatically defined loops, automatically defined recursions, or automatically defined stores).").

186. *See* KSR Int'l Co. v. Teleflex Inc., 127 S. Ct. 1727, 1740 (2007) (holding that a patentable invention cannot result from a process that merely requires a person of ordinary skill in the art to "implement a predictable variation").

ble, generating new knowledge about circuit component interaction. Indeed, it is impossible to completely separate basic scientific knowledge from applied research.[187] Finally, even if one considers a creative algorithm itself an invention, users can apply the algorithm to solve any number of practical problems.[188] An inventive process is not applied knowledge in the sense of being limited to a *particular* practical problem.

Thus, inventive processes are both closely analogous to abstract ideas and necessary to continued scientific discovery. Inventive processes must themselves be considered one of the basic tools essential to everyday science. Without them, the cycle of technological innovation would grind to a halt.

B. STATUTORY PROCESSES AND MACHINES: DEMANDING PREDICTABLE PRODUCTS

Like the common law doctrine, the statutory subject-matter doctrine can be strengthened by recognizing and making explicit what it assumes—that the invention cannot be the inventor. In so limiting the universe of patentable subject matter, § 101 implies that patentable inventions, when later used, predictably produce replicable results.

Section 101 contains two necessarily separate clauses. The first, "[w]hoever invents or discovers," describes the actor and the action, while the second, "any new and useful process, machine, manufacture, or composition of matter," describes the objects of the action.[189] Only the objects of the action, however, are entitled to patent protection. Explicitly recognizing that which distinguishes inventing from invention provides a useful mechanism for limiting patentable subject matter to the objects of § 101. In a narrow sense, every process is creative because it creates something useful. But if it produces only the expected, predicted result, it is not truly inventive.[190] A genuinely inventive process contains a spark of creativity that pushes the process in directions unpredictable at the outset. If unpredictability distinguishes the inventive process, then the beginning of

187. *See* Oskar Liivak, *Maintaining Competition in Copying: Narrowing the Scope of Gene Patents*, 41 U.C. DAVIS L. REV. 177, 179 (2007); *cf.* Lee, *supra* note 118, at 663 n.10 (noting that the line between basic and applied research is increasingly blurry).

188. *See, e.g.*, U.S. Patent No. 6,360,191 claim 1 (filed Jan. 5, 1999) (claiming "[a]n iterative computer-implemented process for creating a structural design that satisfies prespecified design goals").

189. *See* 35 U.S.C. § 101 (2000).

190. *See KSR Int'l Co.*, 127 S. Ct. at 1740.

predictability must determine when an invention finally emerges.

To discern whether a purported invention is in fact an unpatentably abstract process, courts must analyze whether the claimed subject matter can be predictably used to achieve replicable results. For example, courts have defined a process as "'an act, or a series of acts, performed upon the subject-matter to be transformed and reduced to a different state or thing.'"[191] This definition implies, however, that every time the prescribed act or series of acts are performed on the same subject matter, they will transform and reduce that subject matter to the *same* different state or thing. Using the process must achieve predictable and replicable results. If it did not, then the user would be experimenting or inventing, not using. Like a pure mathematical algorithm, the claimed process would have multiple indeterminate uses.[192]

A brief analysis of a genetic algorithm under this framework shows the vitality of statutory subject matter correctly understood. Take, for example, a genetic algorithm claimed as "[a]n iterative computer-implemented process for creating a structural design that satisfies prespecified design goals."[193] This claim likely qualifies as either a process or machine[194] under present statutory subject-matter doctrine. To apply the full force of § 101, a court must take the analysis one step further. It must determine whether the claimed algorithm can be predictably used to achieve replicable results. Assume now that the claimed genetic algorithm is used to create the structural design of a roof truss, capable of supporting a load of 1000 lbs and weighing no more than 100 lbs. On the surface, the results are both predictable and replicable: every time the algorithm is run with these design goals, it outputs a design that meets them. If the algorithm is run ten times, however, it will yield ten different roof truss designs. Each design meets or exceeds the preset criteria,[195] but the roof truss has been transformed

191. *In re* Nuijten, 500 F.3d 1346, 1355 (Fed. Cir. 2007) (quoting Gottschalk v. Benson, 409 U.S. 63, 70 (1972)).

192. *See Benson*, 409 U.S. at 71.

193. This language is taken directly from a granted patent. *See* Method and Apparatus for Automated Design of Complex Structures Using Genetic Programming, U.S. Patent No. 6,360,191 claim 1 (filed Jan. 5, 1999).

194. *See In re* Alappat, 33 F.3d 1526, 1545 (Fed. Cir. 1994) (recognizing the validity of "machine" claims consisting of software and a general purpose computer).

195. For instance, the first design may support 1010.3 lb. and weigh 98.2

into a *different* "different state or thing"[196] every time. Patent law identifies a specific invention by its structure, not its function. Inventors may claim a function without specifying a corresponding structure when using "means-plus-function" claims, but such claims are limited to the specific structure described in the patent's specification.[197] Because a genetic algorithm involves random mutation, a user cannot predict the specific truss structure the algorithm will yield even when given identical initial inputs. Thus, a genetic algorithm cannot be a § 101 process.

This interpretation of subject matter patentability doctrine, with common law doctrine protecting basic research tools and statutory language requiring predictable and replicable use, offers several advantages. Dissenting in *Diamond v. Diehr*, Justice Stevens criticizes case law analyzing the patentability of software for failing to "establish rules that enable a conscientious patent lawyer to determine . . . which, if any, program-related inventions will be patentable."[198] *State Street* established a clear rule but at the cost of an independent subject matter test. This solution strikes a better balance, maintaining a viable subject-matter doctrine while providing patent attorneys with a relatively concrete framework from which to predict patentability.[199] Furthermore, this solution does not chill "intangible" invention generally.[200] Rather, it maintains the patentability of the majority of software currently being developed and recognizes that "many important advances . . . involve intangible information-processing steps."[201] More importantly, however, a strong subject matter patentability doctrine accom-

lb., while the second design supports 1006.8 lb. and weighs 99.4 lb.

196. *See Benson*, 409 U.S. at 70 (defining a statutory "process").

197. *See* 35 U.S.C. § 112, ¶ 6 (2000) ("[S]uch claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.").

198. Diamond v. Diehr, 450 U.S. 175, 219 (1981) (Stevens, J., dissenting).

199. The inability to establish a cohesive, predictable regime governing patentable subject matter has been a longstanding weakness of patent law, particularly in the area of software patents. *See* Burtis, *supra* note 22, at 1129 ("Courts continue to struggle to develop a doctrine of patentable subject matter that is at once stable enough to provide predictability to the marketplace, which makes decisions based on the legal protection available to technology, while maintaining sufficient flexibility to keep abreast of ever-changing technological advancement.").

200. *See* Gruner, *supra* note 22, at 467 (arguing that patent standards should be altered to accommodate information-processing advances and to *encourage* intangible inventions).

201. *Id.* at 360.

plishes what a heightened utility requirement[202] cannot. It excludes from patentability subject matter that is highly useful but nonetheless ill-suited for the protection of a patent monopoly. In doing so, however, it maintains a strong subject matter patentability test anchored entirely in the utilitarian principle that supports American patent law. There is no need to import amorphous moral philosophies, such as the European concept of "ordre public."[203] Finally, and most importantly, application of the subject-matter doctrine as constructed above is not limited to creative algorithms. By focusing the common law on protecting basic tools of research and the statutory test on ensuring inventions that can be predictably used, subject-matter doctrine can continue to effectively confront new and increasingly abstract technologies as they emerge.

CONCLUSION

Courts have consistently struggled to determine whether new fields of invention deserve patent protection. Computer software, in particular, has generated contorted, conflicting, and overlapping analyses, leaving the doctrine of subject matter patentability constantly in flux. By essentially merging the subject matter test into a utility inquiry, the Federal Circuit appeared to have at least settled on a comprehensible and workable approach. Now, two developments—emerging software technology enabling autonomous, creative invention and recent Federal Circuit decisions reasserting the independence of the subject matter test—demand a revised approach to analyzing the patentability of abstract inventions.

Under existing patent law, the common law is incapable of independently excluding any new invention, while statutory subject-matter doctrine cannot adequately distinguish between

202. *See* John M. Golden, *Biotechnology, Technology, Policy, and Patentability: Natural Products and Invention in the American System*, 50 EMORY L.J. 101, 112 (2001) (suggesting that, in the context of biotechnology, "the Patent and Trademark Office ('PTO') and courts should use the utility requirement to impose real, albeit not insurmountable, obstacles" in order to limit what is patented).

203. *See, e.g.*, Katrina McClatchey, *The European Patent Office and the European Patent: An Open Avenue for Biotechnologists and "Living Inventions"*, 2 OKLA. J.L. & TECH. 25, 8 (2004), http://www.okjolt.info/pdf/2004okjoltrev25.pdf (describing the "ordre public" concept: "'[i]nventions, the exploitation of which is not in conformity with the conventionally accepted standards of conduct pertaining to the culture inherent in European society and civilization are to be excluded from patentability as being contrary to morality'" (citation omitted)).

inventor and invention. The solution proposed by this Note gives subject-matter doctrine the renewed relevance necessary to confront broadly abstract inventions such as artificial creative processes by addressing each problem separately. First, courts must apply common law categories of unpatentable subject matter solely as means to identify basic tools of scientific research and ensure they remain freely available. Second, courts must construe § 101 processes and machines to include only those that yield predictable results when used. So understood, subject-matter doctrine can and will continue to serve its necessary role in limiting the patent privilege.