In re Bd. of Trs. of the Leland Stanford Junior Univ., 991 F.3d 1245 (Fed. Cir. March 25, 2021)

United States Court of Appeals for the Federal Circuit

IN RE: BOARD OF TRUSTEES OF THE LELAND STANFORD JUNIOR UNIVERSITY,
Appellant

2020-1288

Appeal from the United States Patent and Trademark Office, Patent Trial and Appeal Board in No. 13/486,982.

Decided: March 25, 2021

JOEL KAUTH, KPPB LLP, Anaheim, CA, argued for appellant. Also represented by DAVID BAILEY, CHRISTIAN HANS, MARK YEH.

MAUREEN DONOVAN QUELER, Office of the Solicitor, United States Patent and Trademark Office, Alexandria, VA, argued for appellee Andrew Hirshfeld. Also represented by THOMAS W. KRAUSE, FRANCES LYNCH, AMY J. NELSON.

Before PROST, *Chief Judge*, LOURIE and REYNA, *Circuit Judges*.

REYNA, *Circuit Judge*.

The Board of Trustees of the Leland Stanford Junior University appeals the final rejection of patent claims in

its patent application. The patent examiner reviewing the application rejected the claims on the grounds that they involve patent ineligible subject matter. On review, the Patent Trial and Appeal Board affirmed the examiner's final rejection of the claims. As discussed below, the rejected claims are drawn to abstract mathematical calculations and statistical modeling, and similar subject matter that is not patent eligible. Accordingly, we affirm the decision of the Patent Trial and Appeal Board.

BACKGROUND

The Board of Trustees of the Leland Stanford Junior University ("Stanford") filed its Application No. 13/486,982 ("'982 application") on June 1, 2012. J.A. 39.[1] The '982 application is directed to computerized statistical methods for determining haplotype phase. A haplotype phase acts as an indication of the parent from whom a gene has been inherited. Haplotype phasing is a process for determining the parent from whom alleles—i.e., versions of a gene—are inherited.

The written description of the '982 application explains that accurately estimating haplotype phase based on genotype data obtained through sequencing an individual's genome "plays pivotal roles in population and medical genetic studies." J.A. 85. The '982 application is directed to methods for inferring haplotype phase in a collection of unrelated individuals. J.A. 65–69. According to the written

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[1] The court notes that this case was consolidated for purposes of oral argument with *In Re: The Board of Trustees of the Leland Stanford Junior University*, Case No. 20-1012, in which we concluded that the claims in U.S. Patent Application No. 13/445,925 ("'925 application") are drawn to patent ineligible subject matter. Both the '925 application and the '982 application involve statistical methods of predicting haplotype phase.

description, although high-throughput DNA sequencing methods provide genotype data for individuals, those methods do not provide haplotype information. J.A. 65–66. Though difficult, it is possible to infer haplotype phase, even without information about relatives, using statistics-based algorithms. J.A. 66. Prior art methods for performing this analysis include PHASE, fastPHASE, and Beagle. J.A. 67–68, 81–82. These methods involve using, among other things, a hidden Markov model ("HMM"), which is a statistical tool used in various applications to make probabilistic determinations of latent variables. *See, e.g.*, J.A. 73, 82.

The written description of the '982 application discloses an embodiment in which a statistical model called PHASE-EM is used to predict haplotype phase. PHASE-EM is allegedly a modified version of the preexisting PHASE model and operates more efficiently and accurately than the PHASE model. J.A. 68. Like prior art statistical models, including the fastPHASE model, PHASE-EM uses "a parameterization [expectation maximization] algorithm" in predicting haplotype phase. J.A. 68–69. PHASE-EM "perform[s] optimization on haplotypes rather than MCMC [Markov chain Monte Carlo] sampling," which is used in PHASE. J.A. 68–69. According to the written description, the computational intensiveness of MCMC sampling makes it difficult to use PHASE to analyze large datasets like those generated in genome-wide association studies. J.A. 68.

The written description further explains that PHASE-EM improves accuracy over existing methods by using a particular type of HMM to predict haplotype phase. *See* J.A. 82–84; *id.* at 50–51 (figures 5–6) (showing PHASE-EM's allegedly reduced error rate). The HMM features variables including a hidden state sequence, an emitted sequence, and jump variables. J.A. 75–76. Increased accuracy is purportedly accomplished by using imputed haplotypes as the hidden states. J.A. 45, 68–69, 74–75, 77.

According to the written description, "[t]his increase in accuracy becomes more pronounced with increasing sample size." *E.g.*, J.A. 69.

The examiner issued a final rejection of claims 1 and 22–43 of the '982 application on grounds that the claims cover patent ineligible abstract mathematical algorithms and mental processes. *See* J.A. 10–12. The Patent Trial and Appeal Board ("Board") affirmed the final rejection of the claims. Claim 1 is representative and recites:

> 1. A computerized method for inferring haplotype phase in a collection of unrelated individuals, comprising:
>
> receiving genotype data describing human genotypes for a plurality of individuals and storing the genotype data on a memory of a computer system;
>
> imputing an initial haplotype phase for each individual in the plurality of individuals based on a statistical model and storing the initial haplotype phase for each individual in the plurality of individuals on a computer system comprising a processor a memory [sic];
>
> building a data structure describing a Hidden Markov Model, where the data structure contains:
>
> > a set of imputed haplotype phases comprising the imputed initial haplotype phases for each individual in the plurality of individuals;
> >
> > a set of parameters comprising local recombination rates and mutation rates;
>
> wherein any change to the set of imputed haplotype phases contained within the data structure automatically results in re-computation of the set of parameters comprising local recombination rates and

> mutation rates contained within the data structure;
>
> repeatedly randomly modifying at least one of the imputed initial haplotype phases in the set of imputed haplotype phases to automatically re-compute a new set of parameters comprising local recombination rates and mutation rates that are stored within the data structure;
>
> automatically replacing an imputed haplotype phase for an individual with a randomly modified haplotype phase within the data structure, when the new set of parameters indicate that the randomly modified haplotype phase is more likely than an existing imputed haplotype phase;
>
> extracting at least one final predicted haplotype phase from the data structure as a phased haplotype for an individual; and
>
> storing the at least one final predicted haplotype phase for the individual on a memory of a computer system.

J.A. 30.[2]

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[2] The only other independent claim is claim 32, which contains essentially the same limitations as those in claim 1, except that claim 32 sets forth the "conditional probabilities" defining the HHM. *See* J.A. 33–34. Claims 22–24 and 26–31, which depend from claim 1, recite the same limitations as corresponding claims 33–35, 37–41, and 43. *See* J.A. 30–36. These limitations add or further define features of the claimed model. *See id.* The same is true for remaining claims 25, 36, and 42, although those dependent claims do not contain limitations corresponding to other dependent claim limitations. *See id.* at 31, 35, 36.

In its analysis of the examiner's rejections, the Board applied the two-step framework established by the Supreme Court for determining patent eligibility. *See Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, 573 U.S. 208 (2014); J.A. 9–20. Addressing step one of the *Alice* inquiry, the Board determined that representative claim 1 is directed to patent ineligible abstract ideas in the form of mathematical concepts, i.e., mathematical relationship, formulas, equations, and calculations. J.A. 10–11. Specifically, the Board explained, claim 1 recites an initial step of receiving genotype data, followed by the mathematical operations of building a data structure describing an HMM and randomly modifying at least one imputed haplotype to automatically recompute the HMM's parameters. *Id.*

The Board also determined that claim 1 recites two abstract mental processes. J.A. 11. First, claim 1 recites the step of "imputing an initial haplotype phase for each individual in the plurality of individuals based on a statistical model," which, according to the Board, does not require a computer implementation. *See id.* Second, claim 1 recites the step of automatically replacing an imputed haplotype phase with a randomly modified haplotype phase when the latter is more likely correct than the former. *See* J.A. 11–12. The Board thus concluded that claim 1 recites abstract ideas.

The Board noted that the additional elements in claim 1 recited generic steps of receiving and storing genotype data in a computer memory, extracting the predicted haplotype phase from the data structure, and storing it in a computer memory. J.A. 12–13. Stanford argued that, here as in *Enfish*, the application of the steps in claim 1 results in improved computer functionality. *Enfish, LLC v. Microsoft Corp.*, 822 F.3d 1327 (Fed. Cir. 2016). The Board determined that the evidence does not support that argument. J.A. 13. The Board explained that Stanford failed to identify any specific disclosures in the specification

asserting that claim 1 results in improved computer functionality. J.A. 12.

The Board also rejected Stanford's argument that claim 1 is patent eligible under *McRO, Inc. v. Bandai Namco Games America Inc.*, 837 F.3d 1299, 1315 (Fed. Cir. 2016). *See* J.A. 13. Stanford argued that haplotype phasing is a computer implemented field, and that under *McRO*, "improvements to computer implemented fields are considered technological improvements." J.A. 14. The Board distinguished *McRO* on the basis that the claimed process there used "a combined order of specific rules that renders information into a specific format that is then used and applied to create desired results: a sequence of synchronized, animated characters." J.A. 14 (quoting *McRO*, 837 F.3d at 1315). The Board noted that claim 1 merely recites a series of computations to produce mathematically predicted haplotype information but does not include steps that apply that information in a practical way. *See* J.A. 14. The Board further acknowledged that claim 1 "may be useful in medical or population genetics studies," but nonetheless claim 1 is devoid of any specific step that applies the information in a useful way, such that the claimed calculations are "integrated" into a practical application. J.A. 15. The Board concluded that claim 1 is directed to an abstract idea that is patent ineligible subject matter under § 101. *See* 35 U.S.C. § 101; *Alice*, 573 U.S. at 217–18; J.A. 10, 16.

Turning to step two of the *Alice* inquiry, the Board reviewed whether claim 1 included additional limitations that, when taken individually or in combination, provided an inventive concept that transformed the abstract idea into patent eligible subject matter. The Board determined that the claim 1 steps of receiving, storing, and extracting data were well-known, routine, and conventional. *See* J.A. 17–19. The Board rejected Stanford's argument that specific computational steps themselves establish patent eligibility. J.A. 18. The Board explained that, although the abstract computational steps "might be a highly significant

discovery in the field of haplotype prediction," that alone is insufficient to establish patent eligibility. J.A. 18. The Board rejected Stanford's argument that claim 1 does not unduly preempt use of an HMM, noting that "the absence of complete preemption does not demonstrate patent eligibility." J.A. 20 (citing *Ariosa Diagnostics, Inc. v. Sequenom, Inc.*, 788 F.3d 1371, 1379 (Fed. Cir. 2015)). The Board affirmed the examiner's rejection of claims 1 and 22–43 under § 101. Stanford appeals. We have jurisdiction pursuant to 35 U.S.C. § 141(a) and 28 U.S.C. § 1295(a)(4)(A).

STANDARD OF REVIEW

We review Board decisions in accordance with the Administrative Procedure Act ("APA"). 5 U.S.C. § 706(2); *Dickinson v. Zurko*, 527 U.S. 150, 152 (1999). Under the APA, we review the Board's legal conclusions de novo and its factual findings for substantial evidence. *ACCO Brands Corp. v. Fellowes, Inc.*, 813 F.3d 1361, 1365 (Fed. Cir. 2016). Substantial evidence is "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." *In re Gartside*, 203 F.3d 1305, 1312 (Fed. Cir. 2000) (quoting *Consol. Edison Co. v. NLRB*, 305 U.S. 197, 229 (1938)).

DISCUSSION

The Supreme Court has articulated a two-step analysis to determine patent eligibility under 35 U.S.C. § 101. *Alice*, 573 U.S. at 217–18. In the first step, we examine whether a claim is directed to patent ineligible subject matter, such as an abstract idea. *Id.* If so, we turn to the second step and examine whether the claims contain an inventive concept sufficient to transform the abstract idea into patent eligible subject matter. *Id.* at 221. In this second step we consider the claim elements individually and as an ordered combination to determine whether any additional limitations amount to significantly more than the ineligible concept. *Id.* at 217–18, 221. A patent eligible claim must do

more than simply recite the abstract idea "while adding the words 'apply it.'" *Id.* at 221.

We conclude, at *Alice* step one, that the reviewed claims of the '982 application are directed to patent ineligible abstract ideas. Specifically, the claims are directed to the use of mathematical calculations and statistical modeling. Courts have long held that mathematical algorithms for performing calculations, without more, are patent ineligible under § 101. *See, e.g.*, *Parker v. Flook*, 437 U.S. 584, 595 (1978) ("[I]f a claim is directed essentially to a method of calculating, using a mathematical formula, even if the solution is for a specific purpose, the claimed method is nonstatutory." (internal citation omitted)); *Gottschalk v. Benson*, 409 U.S. 63, 71–72 (1972) (finding claims patent ineligible because they "would wholly pre-empt the mathematical formula and in practical effect would be a patent on the algorithm itself"); *In re Schrader*, 22 F.3d 290, 294 (Fed. Cir. 1994) (a data gathering step of entering bids was "insufficient to impart patentability to a claim involving the solving of a mathematical algorithm").

Claim 1 is drawn to a "computerized method of inferring haplotype phase in a collection of unrelated individuals." J.A. 30. The mathematical techniques used in the method include "building a data structure describing an [HMM]," and then "repeatedly randomly modifying at least one of the imputed initial haplotype phases" to automatically recompute the parameters of the HMM until the parameters indicate that the most likely haplotype phase is found. *See* J.A. 30. In addition to these mathematical steps, claim 1 recites steps of receiving genotype data, imputing an initial haplotype phase, extracting the final predicted haplotype phase from the data structure, and storing it in a computer memory. *See id.* These generic steps of implementing and processing calculations with a regular computer do not change the character of claim 1 from an abstract idea into a practical application. Claim 1

recites no application, concrete or otherwise, beyond storing the haplotype phase.

We have also examined, at *Alice* step one, whether the claimed advance alleged in the written description demonstrates an improvement of a technological process or merely enhances an ineligible concept. *See, e.g.*, *Athena Diagnostics, Inc. v. Mayo Collaborative Servs., LLC*, 915 F.3d 743, 750 (Fed. Cir. 2019). Stanford suggests that one claimed advance is greater efficiency in computing haplotype phase. *See, e.g.*, Appellant's Br. 10, 27–28, 46–47. But Stanford has forfeited its argument that greater computational efficiency renders claim 1 patent eligible by failing to raise it before the Board. As a result, we will not consider it for the first time on appeal. *In re Watts*, 354 F.3d 1362, 1367 (Fed. Cir. 2004).

Stanford separately suggests that another claimed advance is that the claim steps result in more accurate haplotype predictions. *See, e.g.*, Appellant's Br. 21–22, 29–34, 43, 46. Specifically, Stanford argues that the alleged increase in haplotype prediction accuracy renders claim 1 a practical application rather than an abstract idea. *See id.* at 30. Stanford's cited cases do not support its argument because the cases involve practical, technological improvements extending beyond improving the accuracy of a mathematically calculated statistical prediction. *See, e.g.*, *McRO*, 837 F.3d at 1315 ("The claimed process uses a combined order of specific rules that renders information into a specific format that is then used and applied to create desired results: a sequence of synchronized, animated characters."); *Finjan, Inc. v. Blue Coat Sys., Inc.*, 879 F.3d 1299, 1304 (Fed. Cir. 2018) (finding patent eligible a claim drawn to a behavior-based virus scan that protects against viruses that have been "cosmetically modified to avoid detection by code-matching virus scans"); *Enfish*, 822 F.3d at 1330, 1333 (discussing patent eligible claims directed to "an innovative logical model for a computer database" that included a self-referential table allowing for

greater flexibility in configuring databases, faster searching, and more effective storage); *CardioNet, LLC v. InfoBionic, Inc.*, 955 F.3d 1358, 1368 (Fed. Cir. 2020) (explaining that the claims at issue focus on a specific means for improving cardiac monitoring technology; they are not "directed to a result or effect that itself is the abstract idea and merely invoke generic processes and machinery" (quoting *McRO*, 837 F.3d at 1314)). Unlike the technological improvements made in those cases, the improvement in computational accuracy alleged here does not qualify as an improvement to a technological process; rather, it is merely an enhancement to the abstract mathematical calculation of haplotype phase itself. *See Athena*, 915 F.3d at 750; *Synopsys, Inc. v. Mentor Graphics Corp.*, 839 F.3d 1138, 1151 (Fed. Cir. 2016) ("[A] claim for a *new* abstract idea is still an abstract idea."). The different use of a mathematical calculation, even one that yields different or better results, does not render patent eligible subject matter. Because we conclude that claim 1 is directed to patent ineligible subject matter, we next turn to step two of the *Alice* inquiry.

At step two, we inquire whether any limitations establish an inventive concept that transforms the abstract idea into patent eligible subject matter. *Alice*, 573 U.S. at 217–18. Step two is like a lifeline: it can rescue and save a claim that has been deemed, at step one, directed to non-statutory subject matter.

We conclude that claim 1 is not saved. We find no inventive concept that would warrant treating the use of the claimed algorithms and mathematical calculations as patent eligible subject matter. Further, the recited steps of receiving, extracting, and storing data amount to well-known, routine, and conventional steps taken when executing a mathematical algorithm on a regular computer. Using a conventional computer to receive, extract, and store information does not transform an abstract idea into patent eligible subject matter. *See, e.g.*, *In re Greenstein*, 774 F. App'x 661, 664 (Fed. Cir. 2019) (explaining that the

claims only invoke a computer as a generic tool to store information and record transactions). The written description further illustrates that the mathematical steps performed and the data received are conventional and well understood in the prior art. *See, e.g.*, J.A. 65–69, 74–77, 81–84.

Nor does claim 1 require or result in a specialized computer or a computer with a specialized memory or processor. Indeed, it is hard to imagine a patent claim that recites hardware limitations in more generic terms than the terms employed by claim 1. *See* J.A. 30 (reciting method steps carried out by a "computer system" with a "processor" and a "memory"); *see also Alice*, 573 U.S. at 226 (explaining that the hardware-related terms, "data processing system," "communications controller" and "data storage unit" are "purely functional and generic"); *In re TLI Commc'ns LLC Pat. Litig.*, 823 F.3d 607, 614 (Fed. Cir. 2016) (holding generic computer components insufficient to add an inventive concept to an otherwise abstract idea).

Stanford argues the Board erred by failing to consider all the elements of claim 1 as an ordered combination. *See, e.g.*, Appellant's Br. 41–44. Specifically, Stanford argues that the Board "oversimplif[ied]" claim 1 by characterizing it as "directed to a process of using abstract computation methods to obtain a specific type of information" and then "effectively subsumed" all the steps into that purportedly overgeneralized judicial exception. *Id.* at 41. According to Stanford, it is the specific combination of steps recited in claim 1 "that makes the process novel" and "that provides the increased accuracy over other methods." *Id.* at 43. We are not persuaded. The Board correctly determined that claim 1 simply appends the abstract calculations to the well-understood, routine, and conventional steps of receiving and storing data in a computer memory and extracting a predicted haplotype. The application of those elements results in the mathematical analysis itself, and therefore the claimed method subsists in "the basic tools of scientific

and technological work." *See Alice*, 573 U.S. at 216. Such basic tools are not patent eligible. Nor is novelty the touchstone of patent eligibility. That a specific or different combination of mathematical steps yields more accurate haplotype predictions than previously achievable under the prior art is not enough to transform the abstract idea in claim 1 into a patent eligible application. *See SAP Am., Inc. v. InvestPic, LLC*, 898 F.3d 1161, 1170 (Fed. Cir. 2018) (holding that an advance in financial mathematical techniques does not constitute an inventive concept).

The remaining claims contain no limitations, considered individually or as an ordered combination, that transform the abstract idea into a patent eligible application. Instead, claims 22–43 only further define the mathematical calculations recited in claim 1, which we have held abstract.

CONCLUSION

We have considered Stanford's remaining arguments and find them unpersuasive. For the above reasons, the Board's conclusion that claims 1 and 22–43 are drawn to patent ineligible subject matter under § 101 is affirmed.

AFFIRMED