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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte YIFANG LIU

Appeal 2019-002937
Application 14/230,222
Technology Center 2100

Before ALLEN R. MACDONALD, JEREMY J. CURCURI, and
PHILLIP A. BENNETT, *Administrative Patent Judges*.

CURCURI, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant¹ appeals from the Examiner's decision to reject claims 1 and 28–54. We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE.

¹ We use the word Appellant to refer to “applicant” as defined in 37 C.F.R. § 1.42(a). Appellant identifies the real party in interest as Google LLC. Appeal Br. 1.

CLAIMED SUBJECT MATTER

The claims are directed to “determining mutual information with absolute dependency for feature selection.” Abstract. Claim 1, reproduced below, is illustrative of the claimed subject matter:

1. A computer-implemented method performed by one or more computers of a machine learning system, the method comprising:

receiving, by the one or more computers of the machine learning system, a dataset comprising multiple items of a same type, wherein each item has multiple properties;

determining, for each of multiple iterations, a value representing mutual information between a first property and a second property, wherein, for each iteration, determining the value comprises:

selecting, by the one or more computers of the machine learning system, one of the multiple properties as the first property and another of the multiple properties as the second property; and

determining, by the one or more computers of the machine learning system, the value representing the mutual information between the first property and the second property that are selected for the iteration, wherein the value representing the mutual information is generated using a summation of terms that are generated using logarithm values, and wherein the values of the terms are generated using an absolute value operation that disallows negative logarithm values from decreasing the summation;

based on the determined values representing mutual information between the selected properties from the multiple properties, selecting, by the one or more computers of the machine learning system, a subset of the multiple properties for use in the machine learning system;

receiving, by the one or more computers of the machine learning system, another item of the same type as the multiple items from the dataset, wherein the other item has a known value for at least one of the subset of properties;

predicting, by the one or more computers of the machine learning system, a value for a property of the other item having an unknown value, wherein the value is predicted using a machine learning model of the machine learning system based on the known value for the at least one of the subset of properties; and

providing, by the one or more computers of the machine learning system, the predicted value over a network to a client device for display on a user interface of the client device.

REJECTIONS

Claims 1 and 28–54 stand rejected under 35 U.S.C. § 101 as directed to a judicial exception without significantly more. Final Act. 2–5.

OPINION

Claims 1, 44, and 53 are the independent claims. The Examiner determines the following:

Claim(s) 1, 44, and 53 is/are directed to receiving a dataset, the dataset having multiple items having multiple properties, determining a value representing mutual information between the properties for each iteration, receiving an item of the same type, predicting a value for an unknown property, and providing the value on display. This is an abstract idea of receiving data, applying mathematical manipulations to it, predicting a value for an unknown property, and displaying that value. This is similar to known abstract ideas as “Collecting information, analyzing it, and displaying certain results of the collection and analysis (Electric Power Group)”. For example, the claims receive a data set, i.e. collecting information, the claims determine the mutual information between the values of the dataset and from that,

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predict a value based on the known value, i.e. analyzing it, and providing a display, i.e. displaying result of the analysis.

Final Act. 2; *see also* Final Act. 3–5 (determining claims 1 and 28–54 are not directed to significantly more than the abstract idea), Ans. 3–7.

An invention is patent-eligible if it claims a “new and useful process, machine, manufacture, or composition of matter.” 35 U.S.C. § 101. However, the U.S. Supreme Court has long interpreted 35 U.S.C. § 101 to include implicit exceptions: “[l]aws of nature, natural phenomena, and abstract ideas” are not patentable. *E.g., Alice Corp. v. CLS Bank Int’l*, 573 U.S. 208, 216 (2014).

In determining whether a claim falls within an excluded category, we are guided by the Court’s two-part framework, described in *Mayo* and *Alice*. *Id.* at 217–18 (citing *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66, 75–77 (2012)). In accordance with that framework, we first determine what concept the claim is “directed to.” *See Alice*, 573 U.S. at 219 (“On their face, the claims before us are drawn to the concept of intermediated settlement, *i.e.*, the use of a third party to mitigate settlement risk.”); *see also Bilski v. Kappos*, 561 U.S. 593, 611 (2010) (“Claims 1 and 4 in petitioners’ application explain the basic concept of hedging, or protecting against risk.”).

Concepts determined to be abstract ideas, and thus patent ineligible, include certain methods of organizing human activity, such as fundamental economic practices (*Alice*, 573 U.S. at 219–20; *Bilski*, 561 U.S. at 611); mathematical formulas (*Parker v. Flook*, 437 U.S. 584, 594–95 (1978)); and mental processes (*Gottschalk v. Benson*, 409 U.S. 63, 67 (1972)). Concepts determined to be patent eligible include physical and chemical processes, such as “molding rubber products” (*Diamond v. Diehr*, 450 U.S. 175, 191

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(1981)); “tanning, dyeing, making waterproof cloth, vulcanizing India rubber, smelting ores” (*id.* at 182 n.7 (quoting *Corning v. Burden*, 56 U.S. 252, 267–68 (1853))); and manufacturing flour (*Benson*, 409 U.S. at 69 (citing *Cochrane v. Deener*, 94 U.S. 780, 785 (1876))).

In *Diehr*, the claim at issue recited a mathematical formula, but the Court held that “a claim drawn to subject matter otherwise statutory does not become nonstatutory simply because it uses a mathematical formula.” *Diehr*, 450 U.S. at 187; *see also id.* at 191 (“We view respondents’ claims as nothing more than a process for molding rubber products and not as an attempt to patent a mathematical formula.”). Having said that, the Court also indicated that a claim “seeking patent protection for that formula in the abstract . . . is not accorded the protection of our patent laws, and this principle cannot be circumvented by attempting to limit the use of the formula to a particular technological environment.” *Id.* (citation omitted) (citing *Benson* and *Flook*); *see, e.g., id.* at 187 (“It is now commonplace that an *application* of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection.”).

If the claim is “directed to” an abstract idea, we turn to the second step of the *Alice* and *Mayo* framework, where “we must examine the elements of the claim to determine whether it contains an ‘inventive concept’ sufficient to ‘transform’ the claimed abstract idea into a patent-eligible application.” *Alice*, 573 U.S. at 221 (quotation marks omitted). “A claim that recites an abstract idea must include ‘additional features’ to ensure ‘that the [claim] is more than a drafting effort designed to monopolize the [abstract idea].’” *Id.* (alterations in original) (quoting *Mayo*, 566 U.S. at 77). “[M]erely requir[ing] generic computer implementation[] fail[s] to transform that abstract idea into a patent-eligible invention.” *Id.*

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In January 2019, the U.S. Patent and Trademark Office (USPTO) published revised guidance on the application of § 101. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019) (“2019 Revised Guidance”).² “All USPTO personnel are, as a matter of internal agency management, expected to follow the guidance.” *Id.* at 51; *see also* October 2019 Update at 1.

Under the 2019 Revised Guidance and the October 2019 Update, we first look to whether the claim recites:

- (1) any judicial exceptions, including certain groupings of abstract ideas (i.e., mathematical concepts, certain methods of organizing human activity such as a fundamental economic practice, or mental processes) (“Step 2A, Prong One”); and
- (2) additional elements that integrate the judicial exception into a practical application (*see* MPEP § 2106.05(a)–(c), (e)–(h) (9th ed. Rev. 08.2017, Jan. 2018)) (“Step 2A, Prong Two”).³

2019 Revised Guidance, 84 Fed. Reg. at 52–55.

² In response to received public comments, the Office issued further guidance on October 17, 2019, clarifying the 2019 Revised Guidance. USPTO, *October 2019 Update: Subject Matter Eligibility* (the “October 2019 Update”) (available at https://www.uspto.gov/sites/default/files/documents/peg_oct_2019_update.pdf).

³ This evaluation is performed by (a) identifying whether there are any additional elements recited in the claim beyond the judicial exception, and (b) evaluating those additional elements individually and in combination to determine whether the claim as a whole integrates the exception into a practical application. *See* 2019 Revised Guidance - Section III(A)(2), 84 Fed. Reg. 54–55.

Only if a claim (1) recites a judicial exception and (2) does not integrate that exception into a practical application, do we then look, under Step 2B, to whether the claim:

(3) adds a specific limitation beyond the judicial exception that is not “well-understood, routine, conventional” in the field (*see* MPEP § 2106.05(d)); or

(4) simply appends well-understood, routine, conventional activities previously known to the industry, specified at a high level of generality, to the judicial exception.

2019 Revised Guidance, 84 Fed. Reg. at 52–56.

Are the claims patent-eligible?

Step 1

Claim 1 recites a method, which falls with the “process” category of 35 U.S.C. § 101. Claim 44 recites a system, which falls within the “machine” category of 35 U.S.C. § 101. Claim 53 recites a computer-readable medium, which falls within the “manufacture” category of 35 U.S.C. § 101. Thus, we must determine whether the claim recites a judicial exception and fails to integrate the exception into a practical application. *See* 2019 Revised Guidance, 84 Fed. Reg. at 54–55. If both elements are satisfied, the claim is directed to a judicial exception under the first step of the *Alice/Mayo* test. *See id.*

Step 2A, Prong One

Claim 1 is a method claim, which recites, in part, the following:

determining, by the one or more computers of the machine learning system, the value representing the mutual information between the first property and the second property that are

selected for the iteration, wherein the value representing the mutual information is generated using a summation of terms that are generated using logarithm values, and wherein the values of the terms are generated using an absolute value operation that disallows negative logarithm values from decreasing the summation.

This step covers determining mutual information⁴ of two random variables, and is thus one or more of “mathematical relationships, mathematical formulas or equations, mathematical calculations.” 2019 Revised Guidance, 84 Fed. Reg. 52. These recitations are thus the abstract idea of “[m]athematical concepts.” *Id.*

Claims 44 and 53 recite limitations similar to those discussed with respect to claim 1. Thus, claims 44 and 53 also recite an abstract idea.

Step 2A—Prong Two

Because claims 1, 44, and 53 recite a judicial exception, we next determine if the claims recite additional elements that integrate the judicial exception into a practical application.

In the “Background” section, Appellant’s Specification discloses known techniques for calculating mutual information of random variables. Spec. ¶¶ 3–4.

In the “Background” section, Appellant’s Specification further discloses a first case of two random variables where “the mutual information $I(X,Y)=0.15320219422$. Using a Naïve Bayes classifier, the simple classification accuracy may be 0.910.” Spec. ¶ 6

In the “Background” section, Appellant’s Specification further discloses a second case of two random variables where “the mutual

⁴ The claim recites a modified mutual information calculation that uses an absolute value operation.

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information $I(X, Y) = 0.15666606782$. Using a Naïve Bayes classifier, the simple classification accuracy may be 0.908.” Spec. ¶ 7.

In the “Background” section, Appellant’s Specification discloses the following need:

The first case may present a greater relation between X and Y than the second case, as the simple classification accuracy of the first case is 91 %, while in the second case it’s 90.8%. However, the mutual information values determined according to (1) provide a contradictory result, with the second case having more mutual information than the first case. The positive and negative values of the log term may cancel out in the first case, due to the slope of the log function around $y = 0$, resulting in the value for mutual information for the first case being lower than it should be.

Spec. ¶ 8.

Appellant’s Specification discloses the following solution: a modified mutual information calculation that uses an absolute value operation. Spec. ¶

9. Appellant’s Specification further discloses “[t]he first of the two random variables may be a feature of [an] item, and the second of the two random variables may be a label for the item. The [modified] mutual information may be used in a machine learning system to predict a value for at least one of the random variables for an item for which the value is unknown.” Spec. ¶

10. Appellant’s Specification further discloses “[s]ystems and techniques disclosed herein may allow for the determination of [modified] mutual information with absolute dependency for feature selection in machine learning models.” Spec. ¶ 16.

With respect to applying the modified mutual information calculation that uses an absolute value operation to feature selection in a machine

learning system that predicts a value and provides the predicted value to a user, claim 1 recites the following:

based on the determined values representing mutual information between the selected properties from the multiple properties, selecting, by the one or more computers of the machine learning system, a subset of the multiple properties for use in the machine learning system;

receiving, by the one or more computers of the machine learning system, another item of the same type as the multiple items from the dataset, wherein the other item has a known value for at least one of the subset of properties;

predicting, by the one or more computers of the machine learning system, a value for a property of the other item having an unknown value, wherein the value is predicted using a machine learning model of the machine learning system based on the known value for the at least one of the subset of properties; and

providing, by the one or more computers of the machine learning system, the predicted value over a network to a client device for display on a user interface of the client device.

We conclude these limitations integrate the recited judicial exception of a mathematical concept into a practical application. Under the guidance, a judicial exception may be integrated into a practical application where it provides “an improvement to . . . any other technology or technical field.” MPEP § 2106.05(a). Here, these additional limitations provide an improvement to the technical field of machine learning systems by improving feature selection to improve prediction performance. As explained in the Specification, “[t]he determination of mutual information with absolute dependency between two random variables may be optimized for accuracy, increasing prediction precision.” Spec. ¶ 29. Thus, claim 1 is not directed to an abstract idea.

Claims 44 and 53 recite limitations similar to those discussed with respect to claim 1. Thus, claims 44 and 53 are also not directed to an abstract idea.

Thus, claims 1, 44, and 53 recite additional elements that integrate the judicial exception into a practical application.

Accordingly, we are persuaded by Appellant's argument that:

In the present application, the claims provide clear improvements to the way computer-based machine learning models are built and operate. In claim 1, the improvements include determining a "value representing the mutual information between the first property and the second property ... generated using a summation of terms that are generated using logarithm values ... using an absolute value operation that disallows negative logarithm values from decreasing the summation," selecting "a subset of the multiple properties for use in the machine learning system" "based on the determined values representing mutual information between the selected properties from the multiple properties," and predicting "a value for a property ... having an unknown value ... using a machine learning model of the machine learning system based on the known value for the at least one of the subset of properties." These features, among others, improve machine learning systems to be able to provide "better feature selection" and consequently better predictions than the prior systems, as the Specification discusses.

Appeal Br. 10 (citing Spec. ¶ 23); see also Reply Br. 1–2 ("[T]he claims recite a specific technique showing how the machine learning system can better select the properties or features to be used in a machine learning model.").

We, therefore, do not sustain the Examiner's rejection of claim 1.

We also do not sustain the Examiner's rejection of claims 28-43 and 54, which depend from claim 1.

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Claim 44 recites similar limitations as claim 1. We also do not sustain the Examiner's rejection of claim 44 for the same reasons discussed above when addressing claim 1.

We also do not sustain the Examiner's rejection of claims 45–52, which depend from claim 44.

Claim 53 recites similar limitations as claim 1. We also do not sustain the Examiner's rejection of claim 53 for the same reasons discussed above when addressing claim 1.

CONCLUSION

The Examiner's rejection is reversed.

DECISION SUMMARY

In summary:

Claims Rejected	35 U.S.C. §	Basis	Affirmed	Reversed
1, 28–54	101	Judicial Exception		1, 28–54

REVERSED