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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte PHILIP M. STARHILL

Appeal 2014-008316
Application 12/645,851
Technology Center 2100

Before ROBERT E. NAPPI, CARLA M. KRIVAK, and
JEFFREY A. STEPHENS, *Administrative Patent Judges*.

STEPHENS, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Appellant¹ seeks our review under 35 U.S.C. § 134(a) from the Examiner's Final Rejection of claims 1–20. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm-in-part and enter a new ground of rejection.

¹ The real party in interest is identified as International Business Machines Corporation. (App. Br. 2.)

Claimed Subject Matter

The claimed invention relates to a method, system and computer program product that improve multiplication of a vector by a product of elementary matrices. (Title; Abstract.) Claim 1, reproduced below, is illustrative:

1. A system comprising:
at least one computer processor; and
a controller configured to cause the computer processor to determine which intermediate resultants of a matrix vector product between an input vector and a plurality of elementary matrices can be performed in parallel.

Rejection²

Claims 1–20 stand rejected under 35 U.S.C. § 103(a) as obvious over Bonebakker et al. (US 7,631,171 B2; iss. Dec. 8, 2009) (“Bonebakker”) and Karmarkar et al. (US 5,107,452; iss. Apr. 21, 1992) (“Karmarkar”). (Final Act. 4–12.)

ANALYSIS

We have reviewed the Examiner’s rejection in light of Appellant’s arguments the Examiner erred (App. Br. 4–15; Reply Br. 1–10). We are unpersuaded by Appellant’s contentions as to claims 1–6, 8–13, and 15–19.

² We note Appellant’s Reply Brief contends that the Examiner’s Answer presents new grounds of rejection of the claims under 35 U.S.C. § 102(e) as anticipated by each of Bonebakker and Karmarkar. (Reply Br. 2.) We do not find the Answer presents such new rejections. In the context of the Answer, which maintains the 35 U.S.C. § 103(a) rejection from the Final Action (Ans. 4), we understand the references to § 102(e) to merely indicate the subsection under which Bonebakker and Karmarkar qualify as prior art.

For these claims, we adopt as our own the findings and reasons set forth by the Examiner in the Action from which this appeal is taken and in the Answer (*see* Ans. 13–15).³

As to claims 7, 14, and 20, we agree with Appellant’s contention the Examiner has not shown the combination of Bonebakker and Karmarkar teaches *an integer array NEXT of length NUM_MATRICES contains the index of a next matrix from the plurality of matrices with a non-identity cell in the column whose index is equal to the ROWS[i]* as required by each of these claims.

We highlight and address specific arguments and findings for emphasis as follows.

Claims 1–6, 8–13, and 15–19

Appellant argues Bonebakker and Karmarkar fail to teach or suggest *a controller configured to cause the computer processor to determine which intermediate resultants of a matrix vector product between an input vector and a plurality of elementary matrices can be performed in parallel*, as recited in claim 1. (App. Br. 4–13; Reply Br. 3–6.) According to Appellant, Bonebakker describes threads and instructions, but one of ordinary skill “would not interpret an instruction/thread to be equivalent to the claimed ‘matrix vector product between an input vector and a plurality of elementary matrices’” recited in claim 1. (App. Br. 8, 9.) Appellant contends Bonebakker “does not contemplate analysis of a matrix vector product between an input vector and multiple matrices.” (App. Br. 7.)

³ Throughout this opinion we refer to the Supplemental Examiner’s Answer mailed June 25, 2014.

We are not persuaded by Appellant's arguments. At the outset, we note the Examiner relies on Bonebakker for a matrix vector product between an input vector and a matrix, and on Karmarkar for a matrix being a plurality of elementary matrices as claimed. (Final Act. 4, 5 (citing Bonebakker col. 1, ll. 46–48; Karmarkar col. 16, ll. 13–14).) We agree with the Examiner's findings that Bonebakker's instruction teaches a matrix vector product between an input vector and a matrix. (Ans. 14 (citing Bonebakker Fig. 1A).) Bonebakker's Figures 1A and 1B and their description at column 3, lines 1–20 disclose a “single vector instruction” that is “a vector matrix multiplication operation” between an input vector and a matrix. (*See* Bonebakker col. 3, ll. 10–13, Figs. 1A–1B.) Additionally, we agree with the Examiner that it would have been obvious to use Karmarkar's elementary matrices as Bonebakker's matrix in the vector product to improve matrix multiplication speed and efficiency—a concern shared by Karmarkar (Karmarkar col. 5, ll. 20–30) and Bonebakker (Bonebakker Fig. 1A). (Ans. 14; Final Act. 5.) Thus, the combination of Bonebakker and Karmarkar teaches and suggests the claimed matrix vector product between an input vector and a plurality of elementary matrices as recited in claim 1. (Final Act. 5.)

Appellant additionally argues Bonebakker does not determine which intermediate resultants of a matrix vector product can be performed in parallel, as required by claim 1. (App. Br. 5–11; Reply Br. 3–5.) Appellant recognizes Bonebakker splits a vector instruction across threads that execute in parallel, but contends Bonebakker makes no mention or suggestion of determining which intermediate resultants can be performed in parallel. (App. Br. 6, 7, 10, 11; Reply Br. 4, 5.)

The Examiner finds “since data is part of the instruction/thread, [Bonebakker’s] executing the instruction/thread in parallel also mean[s] that the data is processed in parallel.” (Ans. 14; Final Act. 3, 4 (citing Bonebakker col. 1, ll. 46–50, col. 4, ll. 24–34, col. 4, ll. 62–67, col. 5, ll. 1–3).) The Examiner also finds, and we agree, that “*ascertaining . . . data dependency* through executed instructions is known in the art when it comes to hazard avoidance in instruction pipelining.” (Ans. 15 (emphasis added); *see also* Bonebakker col. 3, ll. 27–30 (“when operations (such as the multiply in matrix multiplication) are independent, the lack of data hazards and branches allow deep pipelining.”).) The Examiner concludes Bonebakker’s mapping a vector operation across parallel threads teaches and suggests determining which intermediate resultants of the vector operation can be performed in parallel, as required by claim 1. (Ans. 14, 15; Final Act. 3, 4.) We agree with the Examiner’s reasonable findings, as Bonebakker discloses at column 3, lines 15–20 and Figures 1A–1B a specific example of a compiler determining which intermediate resultants—from multiplying, summing, and loading matrix vector entries and calculated intermediate values—of a matrix vector product $F=A \times B$ can be performed in parallel. (Final Act. 5; *see* Bonebakker col. 3, ll. 15–20.)

Appellant further contends the Examiner’s combination of Bonebakker and Karmarkar is improper because the combination lacks rational underpinning. (App. Br. 12, 13.) Appellant acknowledges Karmarkar is concerned with matrix multiplication, but contends “Bonebakker makes no mention of matrix multiplication” and therefore one of ordinary skill would not combine the references. (App. Br. 13.) We are not persuaded by Appellant’s arguments for the reasons discussed *supra*

with respect to Bonebakker's Figures 1A–1B, which teach a matrix multiplication operation. (*See also* Bonebakker col. 3, ll. 10–12.) We find the Examiner has provided articulated reasoning with a rational underpinning and we agree with the Examiner that one of ordinary skill in the art would combine Bonebakker with Karmarkar to achieve a faster and more efficient matrix multiplication. (Final Act. 5.)

Accordingly, Appellant's arguments directed to the Examiner's rejection of claim 1 have not persuaded us of error in the Examiner's rejection, and we sustain the rejection of claim 1 under 35 U.S.C. § 103(a) as obvious over Bonebakker and Karmarkar. For the same reasons, we sustain the rejection of independent claims 8 and 15 argued for the same reasons as claim 1, and dependent claims 2–6, 9–13, and 16–19, which Appellant does not argue separately (App. Br. 4, 13.)

Claims 7, 14, and 20

Claim 14 depends from claim 8 (via claims 9–11) and recites, in part, *an integer array NEXT of length NUM_MATRICES contains the index of a next matrix from the plurality of matrices with a non-identity cell in the column whose index is equal to the ROWS[i], where integer array ROWS of length NUM_MATRICES contains an elementary row number for each of the elementary matrices.* Claim 7, which depends from claim 1, and claim 20, which depends from claim 15, recite similar limitations. The Examiner finds Karmarkar's matrix representations via i- and j-Lists teach an integer array NEXT as claimed. (Ans. 15 (citing Karmarkar col. 16, ll. 15–43); Final Act. 8 (citing Karmarkar col. 12, ll. 6–21 & 26–51).)

Appellant argues Karmarkar discloses the i-List specifies a matrix's row position of each entry and the j-List specifies column boundaries in the i-List, but Karmarkar does not teach an integer array NEXT containing the index of a next matrix as recited in claim 14. (App. Br. 14.) We concur with Appellant the Examiner has not shown that Karmarkar's i- and j-Lists teach or suggest the claimed array NEXT. The cited portions of Karmarkar describe i- and j-Lists that specify positions of *a matrix's* non-zero entries to represent that *matrix*, but do not determine an array NEXT that requires an index of *a next matrix* having a non-identity cell column that corresponds to a row of *a previous matrix* as required by claim 14. (See Karmarkar col. 12, ll. 6–21, col. 16, ll. 27–43; Spec. ¶¶ 27, 38 and 42–45, Fig. 2.)⁴

Absent sufficient findings that Karmarkar or Bonebakker teaches an integer array NEXT that contains the index of a next matrix from a plurality of matrices with a non-identity cell in the column whose index is equal to the ROWS[i], on the record before us, we do not sustain the Examiner's rejection of claims 7, 14, and 20 under 35 U.S.C. § 103(a) as obvious over Bonebakker and Karmarkar.

⁴ Appellant's Specification at Figure 2 illustrates an example of a plurality of three matrices, matrix 3 being "the leftmost matrix." (See Spec. ¶ 45, Fig. 2.) Paragraphs 38 and 42–45 in the Specification further describe how an exemplary integer array NEXT is generated by determining the index of a next matrix after matrix 1—in the group of three matrices—for which a non-identity cell is present in the column of index 2, index 2 being equal to the array value at ROWS[1] for matrix 1, and the array value at ROWS[1] being the elementary row number in matrix 1. (See Spec. ¶¶ 38 and 42–45, Figure 2.) Thus, the claimed integer array NEXT requires an index of *a next matrix* having a non-identity cell column that corresponds to a row of *a previous matrix*.

NEW GROUND OF REJECTION OF CLAIMS 1–20
UNDER 35 U.S.C. § 101

Pursuant to our authority under 37 C.F.R. § 41.50(b), we enter a new ground of rejection under 35 U.S.C. § 101 of independent claims 1–20 as directed to non-statutory subject matter for the following reasons.

The Supreme Court has long held that “[l]aws of nature, natural phenomena, and abstract ideas are not patentable.” *Alice Corp. Pty. Ltd. v. CLS Bank Int’l*, 134 S. Ct. 2347, 2354 (2014) (quoting *Assoc. for Molecular Pathology v. Myriad Genetics, Inc.*, 133 S. Ct. 2107, 2116 (2013) (internal quotation marks omitted)). The “abstract ideas” category embodies the longstanding rule that an idea, by itself, is not patentable. *Alice Corp.*, 134 S. Ct. at 2355 (quoting *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972)). Following the *Alice* decision, the United States Patent and Trademark Office published guidance on § 101, including “2014 Interim Guidance on Patent Subject Matter Eligibility,” 79 Fed. Reg. 74618 (Dec. 16, 2014), “July 2015 Update on Subject Matter Eligibility,” 80 Fed. Reg. 45429 (July 30, 2015), and “May 2016 Subject Matter Eligibility Update,” 81 Fed. Reg. 27381 (May 6, 2016), which supplement the “Preliminary Examination Instructions in view of the Supreme Court Decision in *Alice Corporation Pty. Ltd. v. CLS Bank International, et al.*,” Memorandum to the Examining Corps, June 25, 2014.

In *Alice*, the Supreme Court reiterated the framework set out in *Mayo Collaborative Services v. Prometheus Labs., Inc.*, 132 S. Ct. 1289 (2012), for “distinguishing patents that claim laws of nature, natural phenomena, and abstract ideas from those that claim patent-eligible applications of those concepts.” *Alice*, 134 S. Ct. at 2355. After determining that a claim

nominally falls within one of the statutory categories of machine, manufacture, process, or composition of matter, the first step in the analysis is to “determine whether the claims at issue are directed to one of those patent-ineligible concepts.” *Id.* For example, abstract ideas include, but are not limited to, fundamental economic practices, methods of organizing human activities, an idea of itself, and, mathematical formulas or relationships. *Id.* at 2355–57.

If the claims are directed to a patent-ineligible concept, the second step in the analysis is to consider the elements of the claims “individually and ‘as an ordered combination’” to determine whether there are additional elements that “‘transform the nature of the claim’ into a patent-eligible application.” *Id.* (quoting *Mayo*, 132 S. Ct. at 1298, 1297). In other words, the second step is to “search for an ‘inventive concept’—*i.e.*, an element or combination of elements that is ‘sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the [ineligible concept] itself’.” *Id.* (alteration in original) (quoting *Mayo*, 132 S. Ct. at 1294). The prohibition against patenting an abstract idea “‘cannot be circumvented by attempting to limit the use of the formula to a particular technological environment’ or adding ‘insignificant post-solution activity.’” *Bilski v. Kappos*, 561 U.S. 593, 610–11 (2010) (citation omitted). A claim reciting an abstract idea also does not become eligible “merely by adding the words ‘apply it.’” *Bancorp Servs., LLC v. Sun Life Assurance Co. of Can. (U.S.)*, 687 F.3d 1266, 1276 (Fed. Cir. 2012).

In applying the framework set out in *Alice*, and as the first step of the analysis, we find Appellant’s independent claim 8 is directed to a patent-ineligible abstract concept of manipulating data to determine mathematical

characteristics of the data. All the steps of Appellant’s claim 8, including, for example: i) receiving an input vector; and ii) determining which intermediate resultants of a matrix vector product between the input vector and a plurality of elementary matrices can be performed in parallel, are abstract mathematical concepts that could be performed in the human mind, or by a human using a pen and paper, without need of any computer or other machine. *See CyberSource Corp. v. Retail Decisions, Inc.*, 654 F.3d 1366, 1372–73 (Fed. Cir. 2011) (“[A] method that can be performed by human thought alone is merely an abstract idea and is not patent-eligible under § 101.”); *Gottschalk v. Benson*, 409 U.S. 63, 67 (1972) (“[p]henomena of nature . . . , *mental processes*, and abstract intellectual concepts are not patentable, as they are the basic tools of scientific and technological work.” (emphasis added)). Additionally, mental processes remain unpatentable even when automated to reduce the burden on the user of what once could have been done with pen and paper. *CyberSource*, 654 F.3d at 1375 (“That purely mental processes can be unpatentable, even when performed by a computer, was precisely the holding of the Supreme Court in *Gottschalk v. Benson*.”).

Because we find claim 8 to be directed to an abstract idea, we must determine whether the claim as a whole—including all elements or combination of elements—is directed to *significantly more* than the abstract idea itself, i.e., to a patent-eligible application of the abstract idea. *See Alice*, 134 S. Ct. at 2355. Interpreted in the context of the Specification, the claim involves data processing of receiving data (an input vector) and analyzing data to determine if certain intermediate resultants can be performed in parallel. In particular, Appellant’s Specification describes that determining

if intermediate resultants can be performed in parallel is done by analyzing data such as matrices' rows and columns. (*See Spec.* ¶¶ 43–45.) It is possible to perform the method recited in Appellant's claim 8 mentally, or with pen and paper. *See CyberSource*, 654 F.3d at 1375 (holding a method for verifying the validity of a credit card transaction over the Internet non-statutory as an abstract idea capable of being performed in the human mind or by a human using a pen and paper); *Dealertrack, Inc. v. Huber*, 674 F.3d 1315, 1333–34 (Fed. Cir. 2012) (“Simply adding a ‘computer aided’ limitation to a claim covering an abstract concept, without more, is insufficient to render [a] claim patent eligible.”). Thus, as confirmed by Appellant's Specification, the “receiving” and “determining” steps of claim 8 simply involve mathematically manipulating information to generate additional information, which are not patent-eligible steps.

The only element of claim 8 that is not a purely mental or algorithmic step is the “at least one computer processor” that performs the determining step. We find, however, that this limitation does not ensure that the claim amounts to significantly more than the patent-ineligible concept. No particular type of a computer processor is recited in claim 8, thus the limitation requires no more than a computer processor performing its basic function. Claim 8 merely does with a computer what could be done manually—analyzing a matrix vector product to determine characteristics of its intermediate resultants—except for the specific nature, complexity, or volume of the information processed. The mere implementation of an abstract idea via generic computer functions is not sufficient to render a claim patentable. *See Alice*, 134 S. Ct. at 2358 (citing *Mayo*, 132 S. Ct. at 1301).

Weighing these factors, we conclude claim 8 does not amount to significantly more than the recited abstract idea, and it is not patent-eligible under 35 U.S.C. § 101. Accordingly, we further reject claim 8 on this basis.

Turning to dependent claims 9–14, which depend from claim 8, we find these claims do not add anything significantly more to the patent-ineligible concept recited in independent claim 8. Dependent claims 9–11, 13, and 14 specify further processing or calculations on certain specified data or previously calculated data (e.g., determining in claim 9, calculating in claims 10 and 11, deferring calculation in claim 13, and generating data arrays in claim 14), which are again abstract mathematical concepts that could be performed in the human mind, or by a human using a pen and paper, and thus fall under our analysis of claim 8, *supra*. The only elements of dependent claims 9–14 that are not purely mental or algorithmic steps are the “plurality of computer processors” that perform the calculating and deferring steps of claims 10, 11, and 13, the “plurality of computer processors [that] are packages in at least one multicore integrated circuit” in claim 12, and the “computer processor P(j), where P(j) is one of the plurality of computer processors” for which a stored integer is solely accessible in claim 14. These limitations do not ensure that the claims amount to significantly more than the patent-ineligible concept, because the limitations require no more than computer processors performing their basic function. The additional elements involving computer processors in claims 9–14 are well-understood, routine, and conventional limitations, adding nothing that is not already present when the elements are taken individually.

For these reasons as well as those stated with respect to claim 8, we also reject dependent claims 9–14 as ineligible subject matter under 35 U.S.C. § 101.

Independent claim 1 is similar to claim 8, but recites a computer processor and controller configured to perform the steps. Independent claim 15 is similar to claim 8, but recites computer readable program code configured to perform the claimed functions. Claims 1 and 15 also merely perform with a computer what could be done manually—analyzing a matrix vector product to determine characteristics of its intermediate resultants—except for the specific nature, complexity, or volume of the information processed. The mere implementation of an abstract idea via generic computer systems or code is not sufficient to render a claim patentable. *See Alice*, 134 S. Ct. at 2358 (citing *Mayo*, 132 S. Ct. at 1301). For this reason as well as those stated with respect to claim 8, we also reject claims 1 and 15. Dependent claims 2–7 and 16–20 similarly correspond to one of claims 9–14. We reject claims 2–7 and 16–20 for the same reasons given above for claims 9–14.

DECISION

The Examiner’s decision rejecting claims 1–6, 8–13, and 15–19 is affirmed. The Examiner’s decision rejecting claims 7, 14, and 20 is reversed.

We also enter a new ground of rejection of claims 1–20 under 35 U.S.C. § 101 pursuant to our authority under 37 C.F.R. § 41.50(b). Section 41.50(b) provides “[a] new ground of rejection pursuant to this

paragraph shall not be considered final for judicial review.” Section 41.50(b) also provides:

When the Board enters such a non-final decision, the appellant, within two months from the date of the decision, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal as to the rejected claims:

(1) Reopen prosecution. Submit an appropriate amendment of the claims so rejected or new Evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the prosecution will be remanded to the examiner. The new ground of rejection is binding upon the examiner unless an amendment or new Evidence not previously of Record is made which, in the opinion of the examiner, overcomes the new ground of rejection designated in the decision. Should the examiner reject the claims, appellant may again appeal to the Board pursuant to this subpart.

(2) Request rehearing. Request that the proceeding be reheard under § 41.52 by the Board upon the same Record. The request for rehearing must address any new ground of rejection and state with particularity the points believed to have been misapprehended or overlooked in entering the new ground of rejection and also state all other grounds upon which rehearing is sought.

Further guidance on responding to a new ground of rejection can be found in the Manual of Patent Examining Procedure § 1214.01.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED-IN-PART;
37 C.F.R. § 41.50(b)