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(54) Title: PARTITIONED MACHINE LEARNING ARCHITECTURE

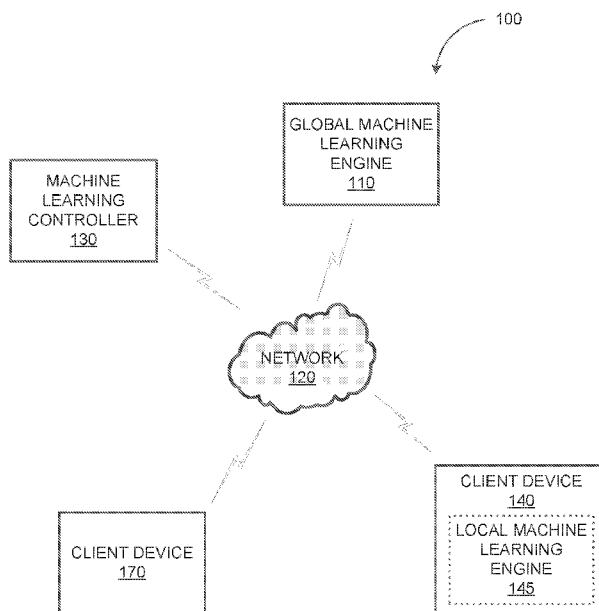


FIG. 1A

(57) Abstract: A system may include a processor and a memory. The memory may include program code that provides operations when executed by the processor. The operations may include: partitioning, based at least on a resource constraint of a platform, a global machine learning model into a plurality of local machine learning models; transforming training data to at least conform to the resource constraint of the platform; and training the global machine learning model by at least processing, at the platform, the transformed training data with a first of the plurality of local machine learning models.



UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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## INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER  
 IPC(8) - G06N 99/00 (2017.01), G06N 3/08 (2017.01)  
 CPC - H04L 63/1425, H04L 63/1458, G06F 21/577, G06N 3/084, G06N 3/0454, G06N 3/08, G06N 99/005

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Que et al. "A Collaborative Framework for Distributed Privacy-Preserving Support Vector Machine Learning." In: AMIA Annu Symp Proc., Nov 03, 2012 [online] [retrieved on 01 November 2017 (01.11.2017)] Retrieved from the Internet <URL: <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3540462/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3540462/</a> >, entire document, especially Abstract; pages 1350-1357	1-69 and 101-102
Y	US 2015/0227838 A1 (WANG et al.), 13 August 2015 (13.08.2015), entire document, especially Abstract; Para [0007], [0009], [0062], [0091]	1-69 and 101-102
Y	US 2014/0358830 A1 (Synopsys, Inc.), 04 December 2014 (04.12.2014), entire document, especially Abstract; Para [0042]-[0044], [0088]	13-14 and 47-48
Y	US 2015/0242741 A1 (QUALCOMM Incorporated), 27 August 2015 (27.08.2015), entire document, especially Abstract; Para [0041]-[0044], [0052]-[0057], [074]-[0077]	16-18, 32-34, 50-52 and 66-67
Y	US 2015/0254575 A1 (Thalchemy Corporation), 10 September 2015 (10.09.2015), entire document, especially Abstract; Para [0021]-[0025], [0037]-[0038]	19 and 53
A	US 2014/0364966 A1 (NEST LABS, INC.), 11 December 2014 (11.12.2014), entire document	1-69 and 101-102
A	US 2015/0193695 A1 (CISCO TECHNOLOGY, INC.), 09 July 2015 (09.07.2015), entire document	1-69 and 101-102
P,A	US 2016/0078361 A1 (Amazon Technologies, Inc.), 17 March 2016 (17.03.2016), entire document	1-69 and 101-102

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 17/16715

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.: 90  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I - Claims 1-69 and 101-102 are directed to a system, method, program product and apparatus for training global machine learning model with local machine learning models.

Group II - Claims 70-89 are directed to a method for performing a learning task.

Group III - Claims 91-100 are directed to a method for customizing the training and/or execution of a learning algorithm.

--- ( See Continuation in Supplemental Box ) ---

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-69 and 101-102

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 17/16715

Continuation of:

Box III. Observations where unity of invention is lacking

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features:

The invention of Group I included the features of partitioning, based at least on a resource constraint of a platform, a global machine learning model into a plurality of local machine learning models; training/executing the global machine learning model by at least processing, at the platform, the transformed training data with a first of the plurality of local machine learning models, not required by any other groups.

The invention of Group II included the features of receiving a stream of training samples, wherein each of the training samples is a vector comprising a plurality of values for a respective plurality of features; for each training sample: computing a projection error for the training sample relative to a column space of a current dictionary matrix; then the projection error is greater than an error threshold, concatenating a scaled version of the training sample to the current dictionary matrix; and training a learning algorithm using a plurality of the transformed samples and a respective plurality of training labels to obtain values of parameters of the learning algorithm, not required by any other groups.

The invention of Group III included the features of selecting preprocessing parameters based on user constraints and/or physical constraints of the target platform, wherein the preprocessing parameters include one or more of the following: a maximum number of features in each projected sample that results from the projection of the raw data samples or a maximum number of columns allowed in the dictionary; storing the preprocessing parameter in a memory of the target platform to at least enable the target platform to perform the training and/or execution of the learning algorithm, not required by any other groups.

Common Technical Features

Group I-III share the technical feature of training a learning algorithm.

Group I-II share the technical feature of transformed training sample.

Group II-III share the technical feature of a sparsity level  $k$  to which raw data samples are to be projected relative to a dictionary.

However, the shared technical features does not represent a contribution over prior art as being anticipated by US 2014/0079297 A1 to Tadayon et al. (hereinafter 'Tadayon'), 20 March 2014 (20.03.2014).

Tadayon teaches transformed training sample (Para [0291], [0904] - transformation for rendering the image or on the provided data sample; to learn the samples more efficiently for a learning machine, we want to use low dimensionality (reduce degrees of freedom for original data), using a transformation technique); training a learning algorithm (Para [0284]- the features of the training samples are learned, e.g., via an unsupervised learning algorithm); a sparsity level  $k$  to which raw data samples are to be projected relative to a dictionary (Para [0.385], [0403], [0901 - enough training and samples, with all the weights and PEs set, we set all the recognition for letter-level recognition in the language at the second hidden layer; each module is optimized on a subset of samples. So, in a first level, we figure out and sort based on the regions of the world, on a coarse and quick basis, and on the second level of analysis; the unit blocks used here for our dictionary of our basic sound pieces are: BEE, BEEM, BAM, and BOOM).

As the common features were known in the art at the time of the invention, this cannot be considered a common technical feature that would otherwise unify the groups. Therefore, Groups I-III lack unity under PCT Rule 13.