(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 October 2015 (01.10.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/148190 A3

(51) **International Patent Classification**:
G06N 3/04 (2006.01) *G06N 3/08* (2006.01)

(21) **International Application Number**:
PCT/US2015/021092

(22) **International Filing Date**:
17 March 2015 (17.03.2015)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
61/970,807 26 March 2014 (26.03.2014) US
14/659,516 16 March 2015 (16.03.2015) US

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, 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).

[Continued on next page]

(54) **Title**: TRAINING, RECOGNITION, AND GENERATION IN A SPIKING DEEP BELIEF NETWORK (DBN)

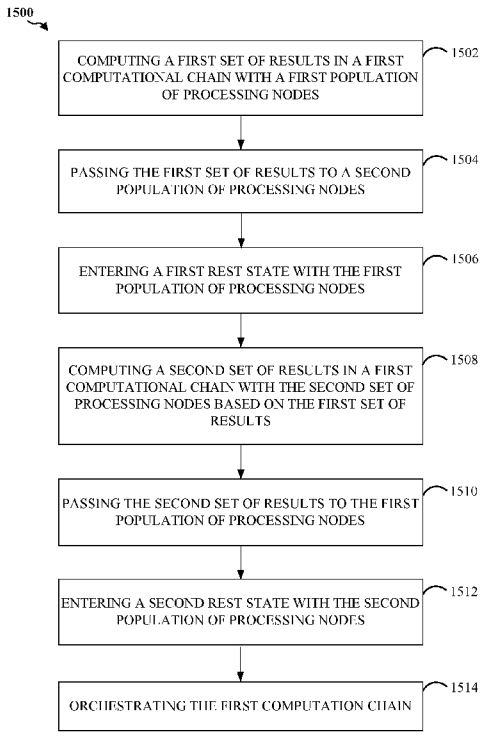

FIG. 15

(57) **Abstract**: A method of distributed computation includes computing a first set of results in a first computational chain with a first population of processing nodes and passing the first set of results to a second population of processing nodes. The method also includes entering a first rest state with the first population of processing nodes after passing the first set of results and computing a second set of results in the first computational chain with the second population of processing nodes based on the first set of results. The method further includes passing the second set of results to the first population of processing nodes, entering a second rest state with the second population of processing nodes after passing the second set of results and orchestrating the first computational chain.

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Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:
10 December 2015

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/021092

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06N3/04 G06N3/08
ADD.

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)
G06N

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	E. NEFTCI ET AL: "Event-driven contrastive divergence for spiking neuromorphic systems", FRONTIERS IN NEUROSCIENCE, vol. 7, 272, 30 January 2014 (2014-01-30), XP055218818, DOI: doi: 10.3389/fnins.2013.00272 the whole document ----- P. O'CONNOR ET AL: "Real-time classification and sensor fusion with a spiking deep belief network", FRONTIERS IN NEUROSCIENCE, vol. 7, 178, 8 October 2013 (2013-10-08), XP055177011, DOI: 10.3389/fnins.2013.00178 the whole document ----- -/--	17-34 17-34

[X] 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	Date of mailing of the international search report
8 October 2015	19/10/2015

Name and mailing address of the ISA/	Authorized officer
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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	J. BREA ET AL: "Sequence learning with hidden units in spiking neural networks", PROCEEDINGS OF THE 25TH ANNUAL CONFERENCE ON NEURAL INFORMATION PROCESSING SYSTEMS (NIPS'24), 12 December 2011 (2011-12-12), pages 1422-1430, XP055207334, ISBN: 978-1-61839-599-3 the whole document	17-34
X	C. SAVIN ET AL: "Independent component analysis in spiking neurons", PLOS COMPUTATIONAL BIOLOGY, vol. 6, no. 4, E1000757, 22 April 2010 (2010-04-22), XP055219056, DOI: 10.1371/journal.pcbi.1000757 the whole document	17-34
A	B. NESSLER ET AL: "Bayesian computation emerges in generic cortical microcircuits through spike-timing-dependent plasticity", PLOS COMPUTATIONAL BIOLOGY, vol. 9, no. 4, E1003037, 25 April 2013 (2013-04-25), XP055218935, DOI: 10.1371/journal.pcbi.1003037 Introduction STDP approximates Expectation Maximization Discussion	17-34
A	M. N. Galtier, G. Wainrib: "A combination of STDP, Hebbian learning and synaptic scaling deriving from a theoretical learning principle", arXiv:1206.4812v1, 21 June 2012 (2012-06-21), XP055218964, Retrieved from the Internet: URL:http://arxiv.org/abs/1206.4812v1 [retrieved on 2015-10-08] Introduction Results Discussion	17-34
A	D. JIMENEZ REZENDE ET AL: "Variational learning for recurrent spiking networks", PROCEEDINGS OF THE 25TH ANNUAL CONFERENCE ON NEURAL INFORMATION PROCESSING SYSTEMS (NIPS'24), 12 December 2011 (2011-12-12), pages 136-144, XP055159175, ISBN: 978-1-61839-599-3 sections 1, 2 and 4	17-34

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	A. GORCHETCHNIKOV ET AL: "Review and unification of learning framework in Cog Ex Machina platform for memristive neuromorphic hardware", NEURAL NETWORKS (IJCNN), THE 2011 INTERNATIONAL JOINT CONFERENCE ON, IEEE, 31 July 2011 (2011-07-31), pages 2601-2608, XP031971018, DOI: 10.1109/IJCNN.2011.6033558 sections I, II and IV.C -----	17-34

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/021092

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. [X] Claims Nos.: 1-16
because they relate to subject matter not required to be searched by this Authority, namely:

see FURTHER INFORMATION sheet PCT/ISA/210

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.:
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:

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 an 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.:

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.

Continuation of Box II.1

Claims Nos.: 1-16

Independent claim 1 seeks protection for any "method of distributed computation, comprising: computing [...] results in a [...] computational chain [...] with processing nodes; passing [...] results to [...] processing nodes; entering a [...] state with [...] processing nodes after passing [...] results; computing [...] results in the [...] computational chain [...] with processing nodes based [...] on [...] results; passing [...] results to [...] processing nodes; entering a [...] state with [...] processing nodes after passing [...] results; and orchestrating the [...] computational chain." The scope of protection is not limited to technical implementations of "processing nodes", that are "computing [...] results" and "entering a [...] state", nor to technical interpretations of "passing [...] results" and "orchestrating the [...] computational chain", but covers any arbitrary abstract "method of distributed computation". In addition, the non-specific references to "processing nodes" and "computational chain" are not supported by the description which specifically relates to spiking neural networks (paragraphs 68-153) i.e. scientific and mathematical models of biological neurons and synapses. Dependent claims 2-16 fail to define features that would lend a technical character to the matter for which protection is sought, as they are not limiting the indicated steps to technical activities, and introduce steps also directed to abstract activities. Therefore, insofar as claims 1-16 comply with Art. 6 PCT, their subject-matter is relates as such to a matter similar to, or closely analogous to, the matters listed under Rule 39.1(i),(iii)&(vi) PCT.