



(51) International Patent Classification:
G06F 11/36 (2006.01) *G06N 3/08* (2006.01)

(21) International Application Number:
PCT/US2019/054075

(22) International Filing Date:
01 October 2019 (01.10.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/793,500 17 January 2019 (17.01.2019) US

(71) Applicant: VISA INTERNATIONAL SERVICE
ASSOCIATION [US/US]; P.O. Box 8999, San Francisco,
California 94128 (US).

(72) Inventor: WANG, Ke; 409 Purisima Avenue, Sunnyvale,
California 94086 (US).

(74) Agent: JEWIK, Patrick R.; Kilpatrick Townsend &
Stockton LLP, Mailstop: IP Docketing - 22 1100 Peachtree
Street, Suite 2800, Atlanta, Georgia 30309 (US).

(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, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, 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.

(54) Title: A DEEP LEARNING MODEL FOR LEARNING PROGRAM EMBEDDINGS

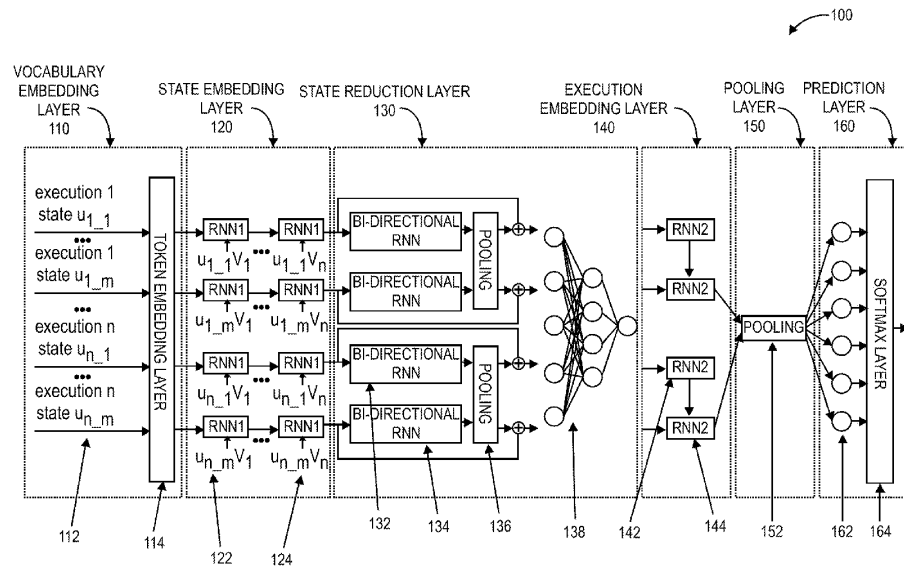


FIG. 1

(57) Abstract: A system and method for using a deep learning model to learn program semantics is disclosed. The method includes receiving a plurality of execution traces of a program, each execution trace comprising a plurality of variable values. The plurality of variable values are encoded by a first recurrent neural network to generate a plurality of program states for each execution trace. A bi-directional recurrent neural network can then determine a reduced set of program states for each execution trace from the plurality of program states. The reduced set of program states are then encoded by a second recurrent neural network to generate a plurality of executions for the program. The method then includes pooling the plurality of executions to generate a program embedding and predicting semantics of the program using the program embedding.

[Continued on next page]

(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).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

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