



(51) International Patent Classification:

G06N 3/045 (2023.01) G06N 3/0495 (2023.01)
G06N 3/042 (2023.01) G06N 3/08 (2006.01)

(21) International Application Number:

PCT/US2025/011935

(22) International Filing Date:

16 January 2025 (16.01.2025)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/621,951 17 January 2024 (17.01.2024) US

(71) Applicant: **VISA INTERNATIONAL SERVICE ASSOCIATION** [US/US]; PO BOX 8999, SAN FRANCISCO, California 94128 (US).

(72) Inventors: **XU, Minghua**; P.O. BOX 8999, SAN FRANCISCO, California 94128 (US). **CHEN, Huiyuan**;

P.O. BOX 8999, SAN FRANCISCO, California 94128 (US). **PAN, Menghai**; P.O. BOX 8999, SAN FRANCISCO, California 94128 (US). **CHEN, Yuzhong**; P.O. BOX 8999, SAN FRANCISCO, California 94128 (US). **DOU, Yingtong**; P.O. BOX 8999, SAN FRANCISCO, California 94128 (US). **DAS, Mahashweta**; P.O. BOX 8999, SAN FRANCISCO, California 94128 (US).

(74) Agent: **RACZKOWSKI, David B.** et al.; Kilpatrick, Townsend & Stockton LLP, 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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,

(54) Title: NEURAL NETWORKS FOR MIXED DATA TYPES

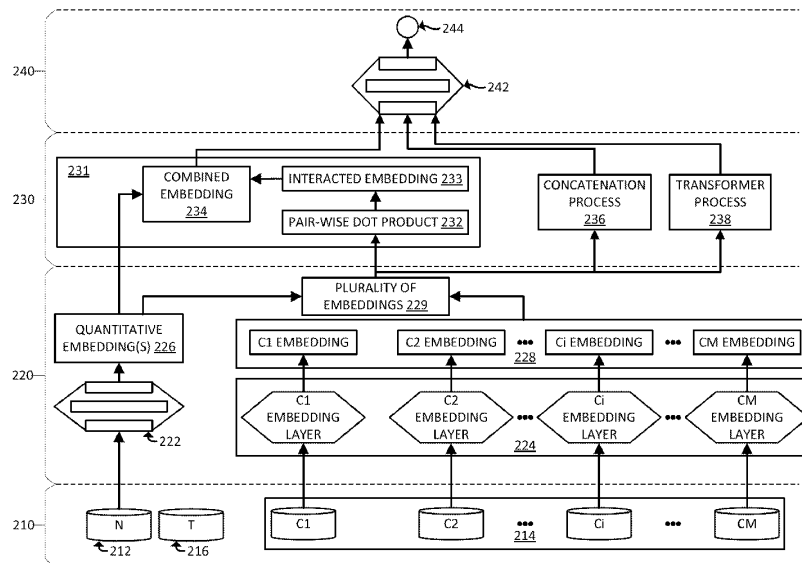


FIG. 2

(57) Abstract: A method includes a computer system obtaining input data comprising quantitative data and categorical data. The categorical data corresponds to a plurality of categories. The computer system can determine one or more quantitative embeddings for the quantitative data using a transformer. The computer system can determine a plurality of categorical embeddings for the plurality of categories using a plurality of embedding layers. The computer system can determine a combined embedding based on the one or more quantitative embeddings and the plurality of categorical embeddings. The computer system can generate a prediction based on the combined embedding for the input data.

[Continued on next page]

RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UY, UZ, VC, VN,
WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, 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, ME, 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).

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))*