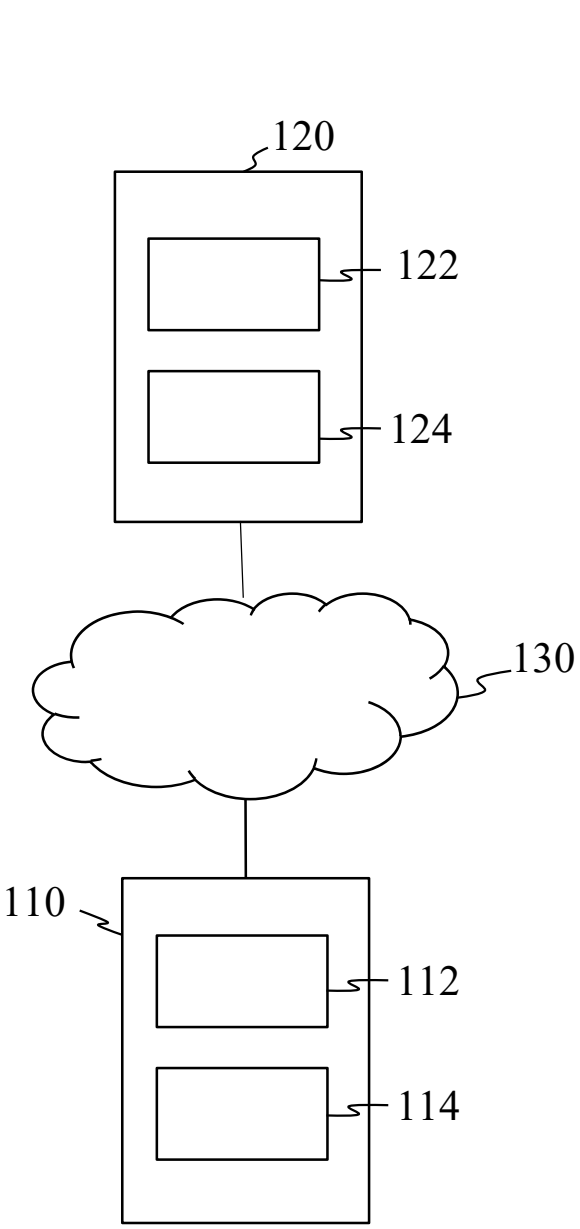


FIG. 1

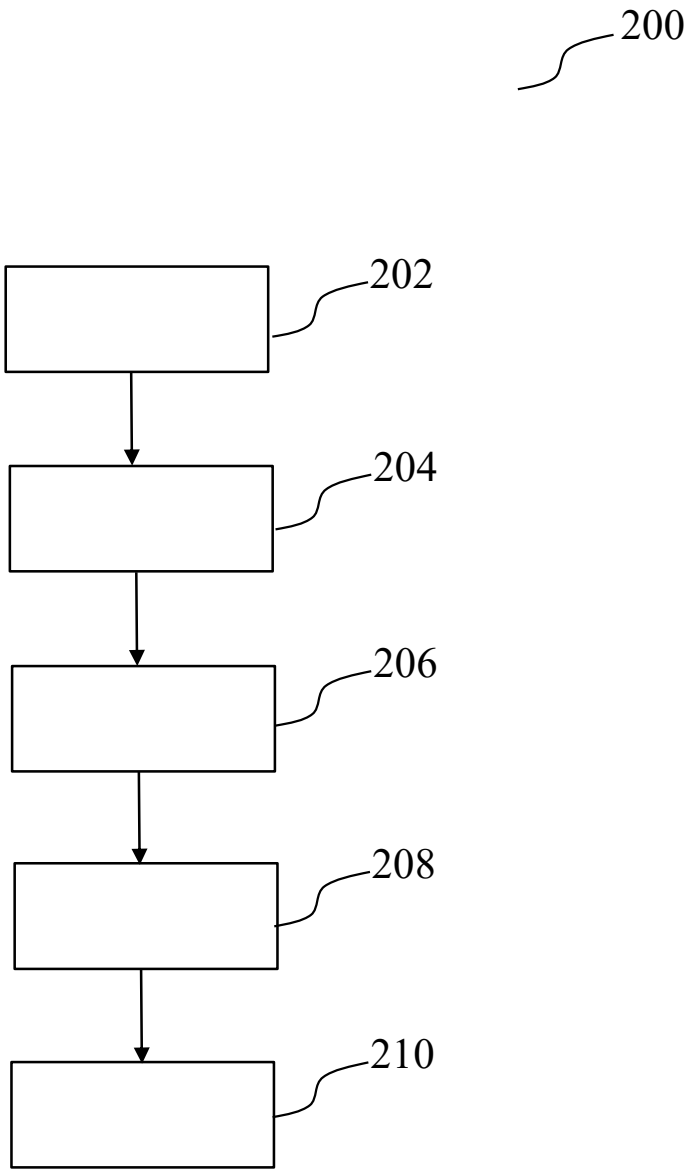


FIG. 2

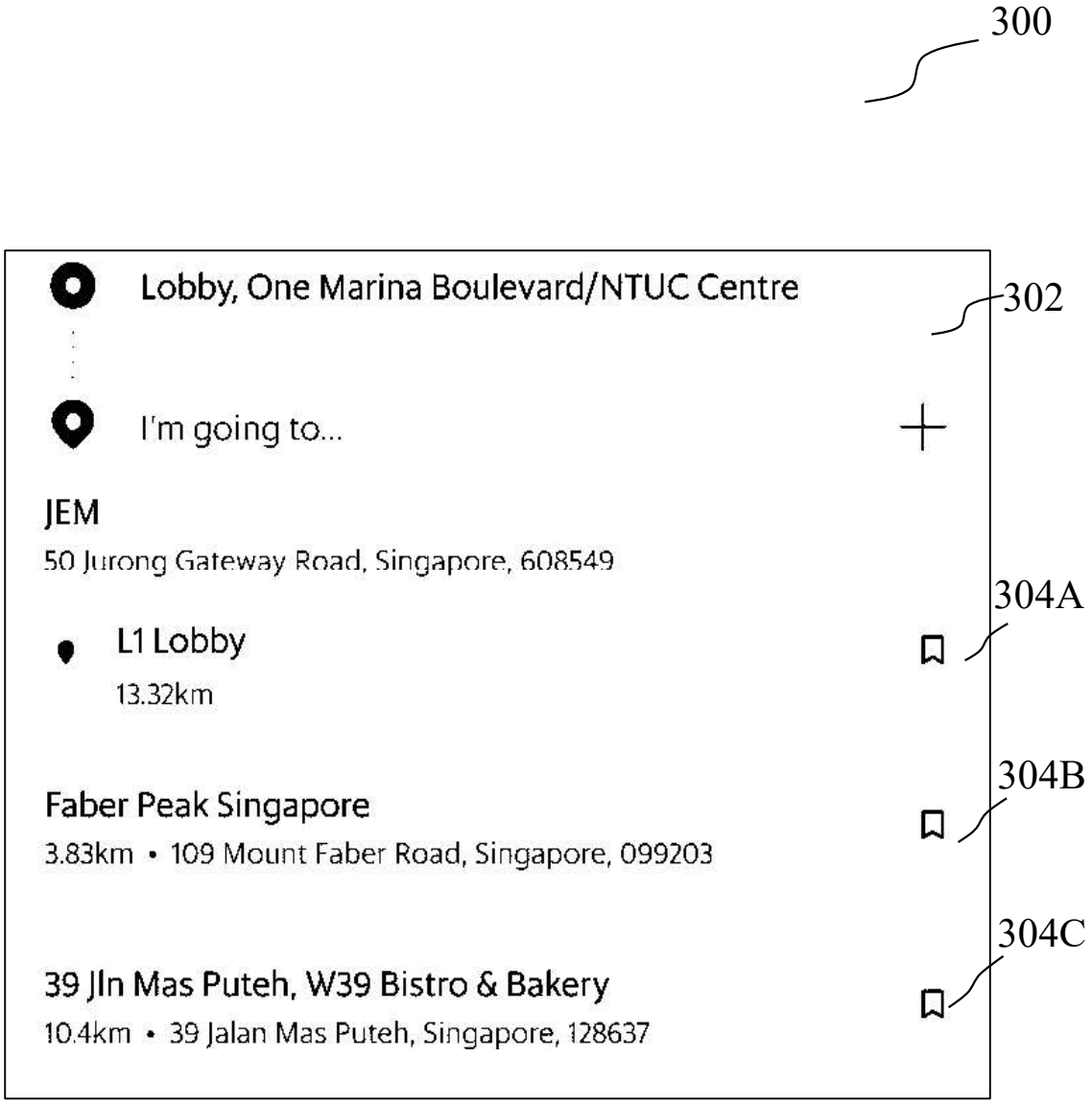

300
Lobby, One Marina Boulevard/NTUC Centre
302
I'm going to...
JEM
50 Jurong Gateway Road, Singapore, 608549
304A
L1 Lobby
13.32km
304B
Faber Peak Singapore
3.83km • 109 Mount Faber Road, Singapore, 099203
304C
39 Jln Mas Puteh, W39 Bistro & Bakery
10.4km • 39 Jalan Mas Puteh, Singapore, 128637

FIG. 3

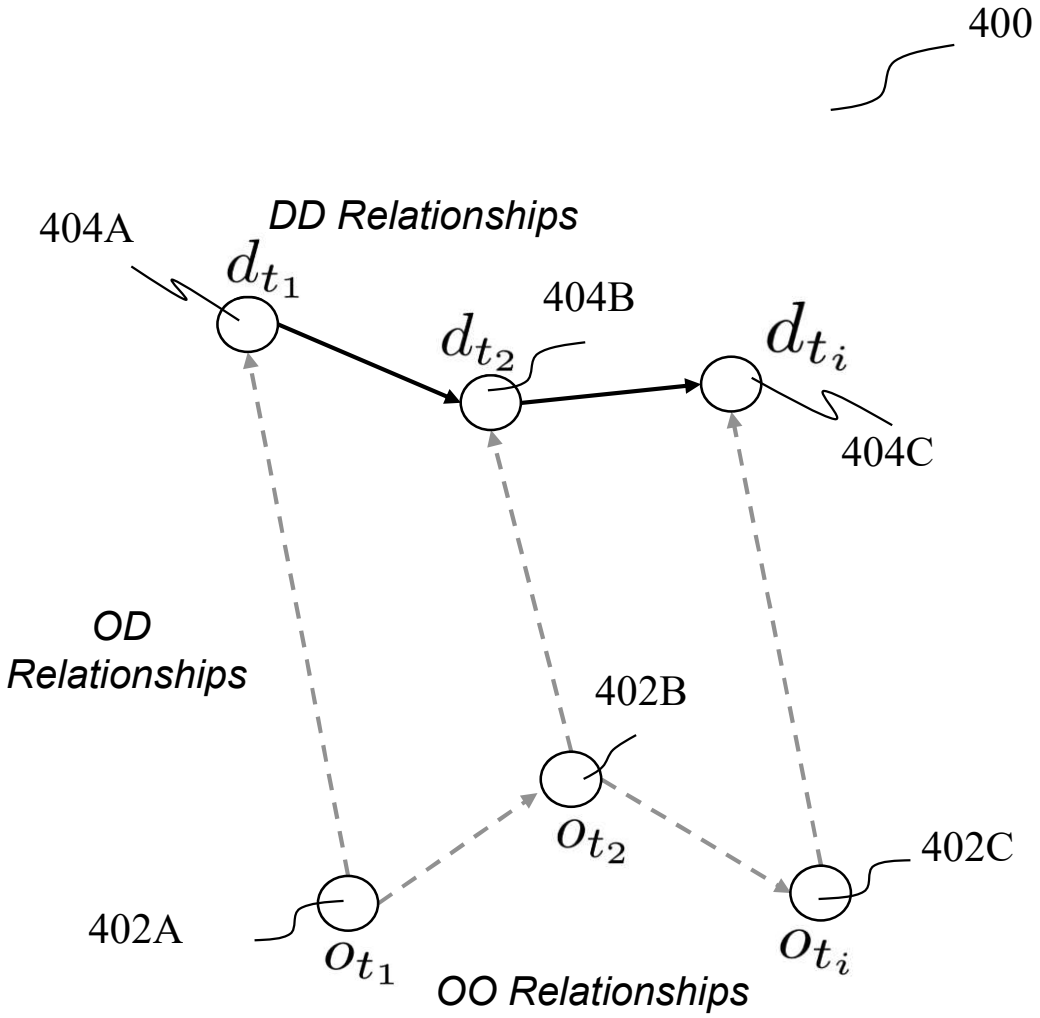

400
404A
DD Relationships
d_{t_1}
404B
d_{t_2}
d_{t_i}
404C
OD
Relationships
402B
o_{t_2}
402C
402A
o_{t_1}
o_{t_i}
OO Relationships

FIG. 4

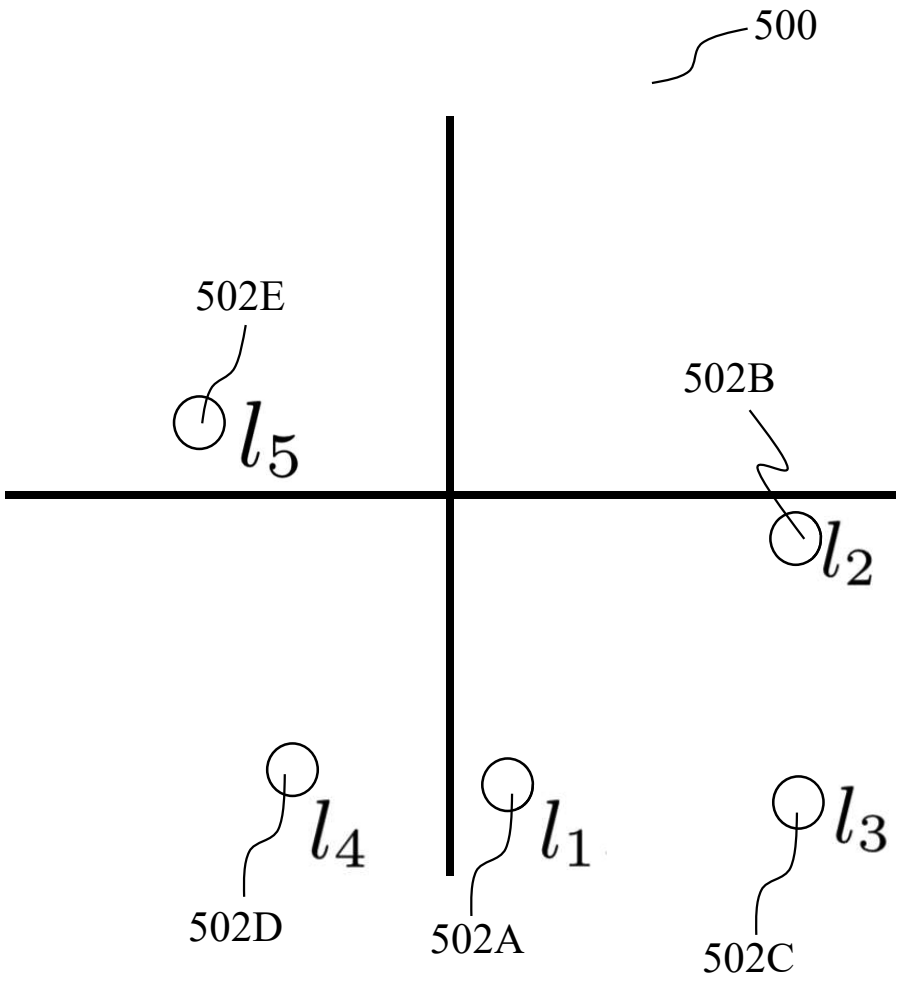


FIG. 5A

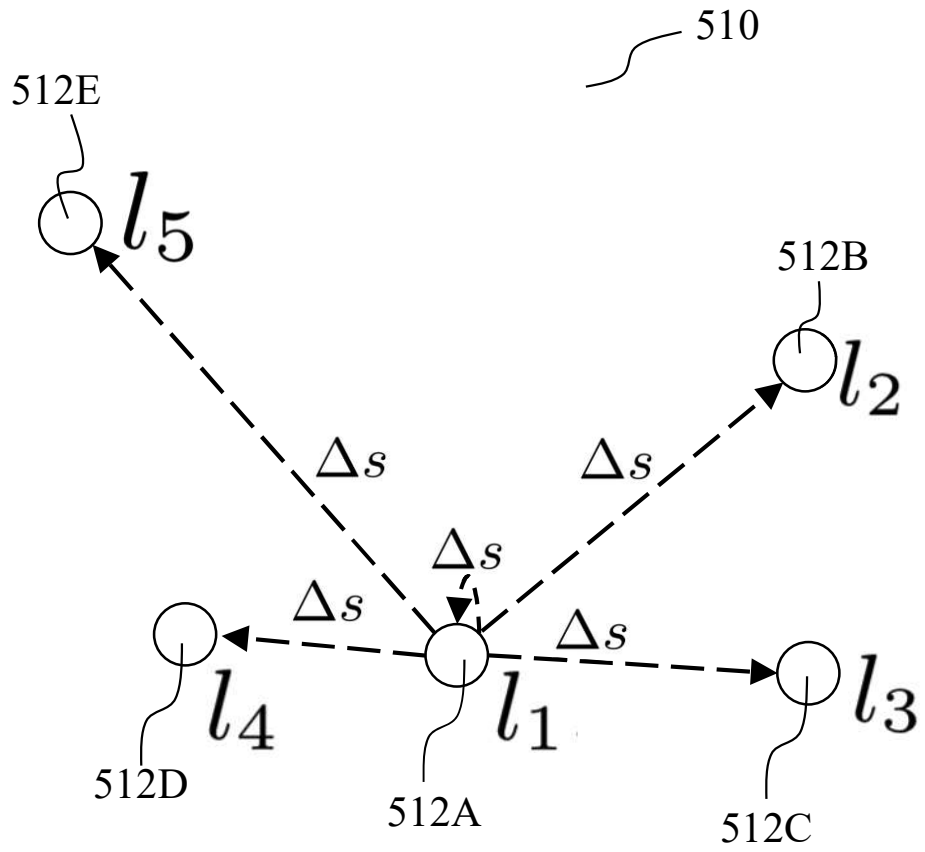

510
512E
l_5
512B
l_2
Δs
Δs
Δs
Δs
Δs
l_4
l_1
l_3
512D
512A
512C

FIG. 5B

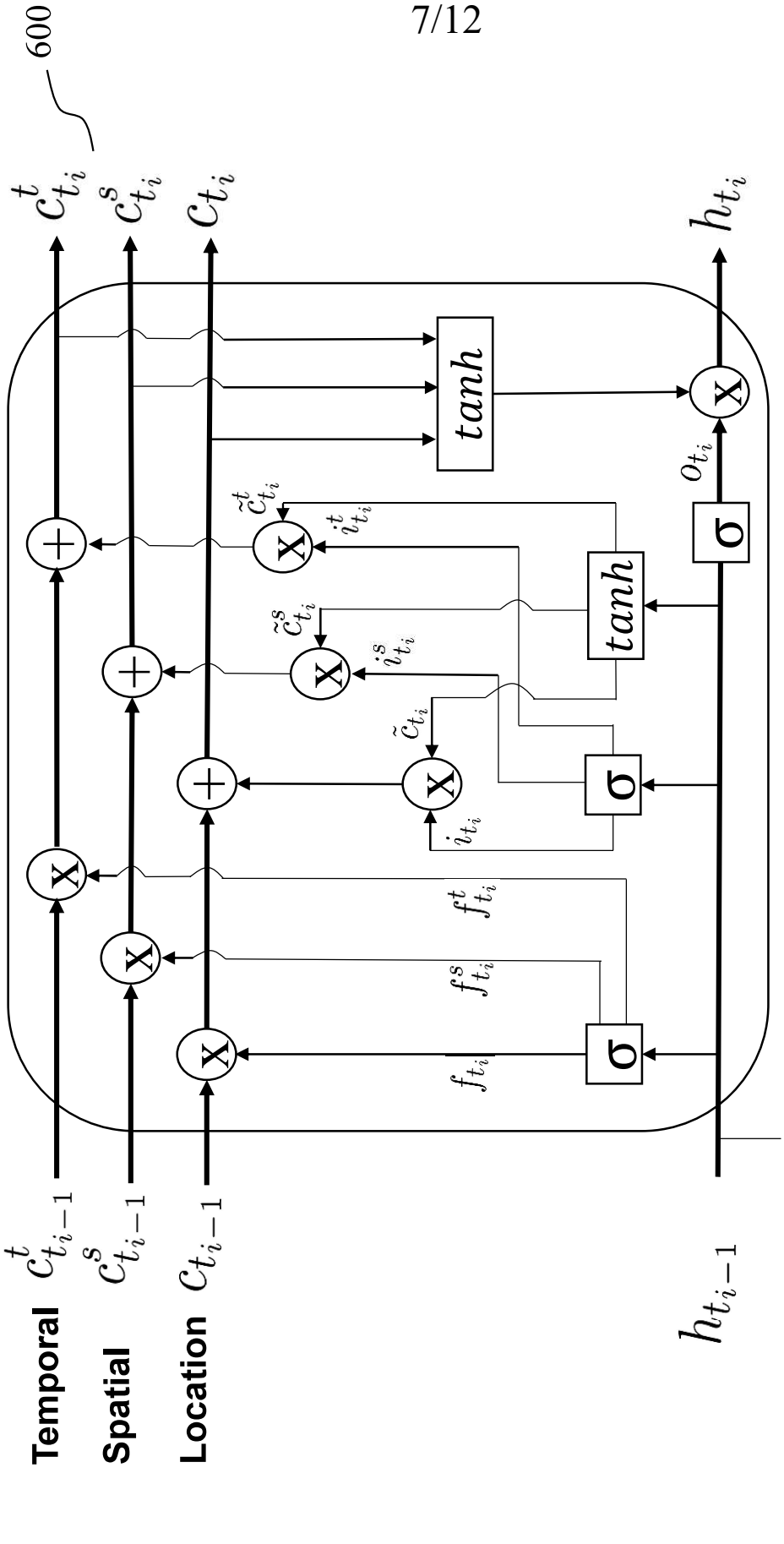

600
Temporal
Spatial
Location
Input:
Location
Geohash
Intervals
Spatial
Timeslot
Intervals
Temporal
tanh
tanh
σ
σ
σ

FIG. 6

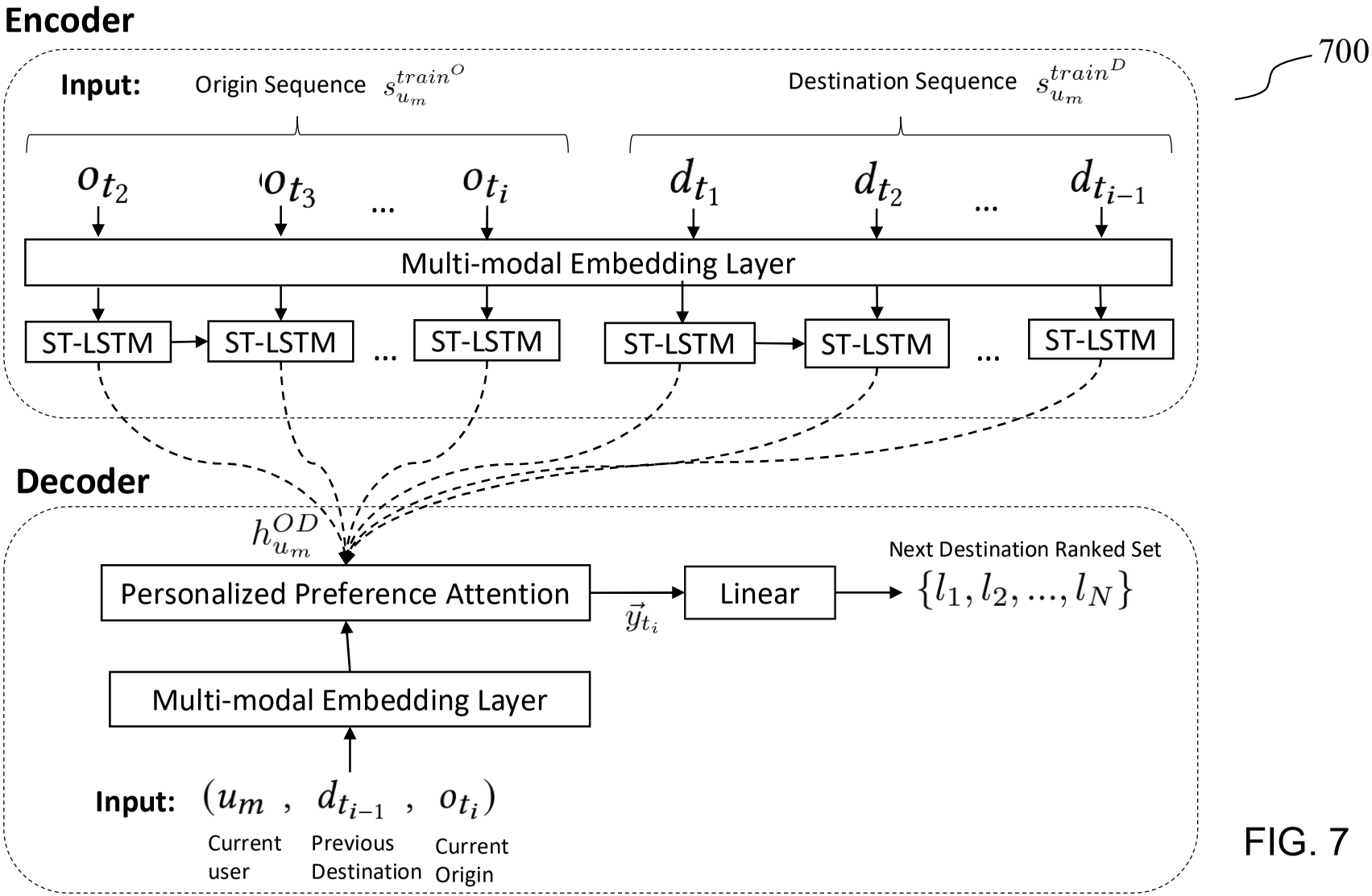

Encoder
Input:
Origin Sequence $s_{u_m}^{train^O}$
Destination Sequence $s_{u_m}^{train^D}$
o_{t_2}
o_{t_3}
...
o_{t_i}
d_{t_1}
d_{t_2}
...
$d_{t_{i-1}}$
Multi-modal Embedding Layer
ST-LSTM
ST-LSTM
...
ST-LSTM
ST-LSTM
ST-LSTM
...
ST-LSTM
Decoder
$h_{u_m}^{OD}$
Personalized Preference Attention
$\vec{y}_{t_i}$
Linear
Next Destination Ranked Set
$\{l_1, l_2, ..., l_N\}$
Multi-modal Embedding Layer
Input: $(u_m , d_{t_{i-1}} , o_{t_i})$
Current user
Previous Destination
Current Origin
700

FIG. 7

Datasets	#users	#locations	#origins	#destinations	#trips
SE-1	2,662	1,694	1,131	563	23,730
SE-2	2,595	1,523	1,008	515	22,867
SE-3	2,677	1,469	972	497	21,164
SE-4	3,083	1,625	1,003	622	24,344
SE-5	2,452	1,397	891	506	22,256
SE-6	1,363	1,001	642	359	21,156
SE-7	3,301	2,044	1,315	729	23,019

FIG. 8A

		TOP	U-TOP	TAXI	MF	RNN	GRU	LSTM	HST-LSTM	STGN	STGCN	LSTPM	LSTPM-OD	STOD-PPA
SE-1	Acc@1	0.0000	0.1344	0.0000	0.0155	0.1694	0.1621	0.2039	0.1103	0.0294	0.0530	0.3402±0.001	0.3683±0.002	**0.4173±0.002**
	Acc@5	0.0127	0.5275	0.0139	0.0232	0.2340	0.2348	0.2978	0.2181	0.1012	0.1407	0.5001±0.002	0.5357±0.002	**0.5615±0.001**
	Acc@10	0.0246	0.5791	0.0280	0.0380	0.2642	0.2694	0.3388	0.2737	0.1501	0.2019	0.5380±0.003	0.5689±0.002	**0.5846±0.002**
	MAP	0.0147	0.2956	0.0170	0.0294	0.2039	0.2006	0.2517	0.1666	0.0724	0.1040	0.4162±0.001	0.4482±0.001	**0.4865±0.002**
SE-2	Acc@1	0.0000	0.1250	0.0000	0.0164	0.1651	0.1636	0.2055	0.1051	0.0380	0.0525	0.3260±0.002	0.3617±0.002	**0.4108±0.002**
	Acc@5	0.0101	0.5233	0.0115	0.0267	0.2555	0.2648	0.3300	0.2324	0.1266	0.1588	0.5064±0.001	0.5434±0.002	**0.5761±0.002**
	Acc@10	0.0469	0.5814	0.0471	0.0453	0.2917	0.3104	0.3833	0.2937	0.1818	0.2270	0.5582±0.002	0.5889±0.002	**0.6077±0.002**
	MAP	0.0199	0.2906	0.0209	0.0316	0.2119	0.2150	0.2678	0.1702	0.0900	0.1119	0.4119±0.001	0.4477±0.001	**0.4895±0.001**
SE-3	Acc@1	0.0000	0.1285	0.0000	0.0123	0.1129	0.1003	0.1344	0.0652	0.0285	0.0384	0.2848±0.001	0.3163±0.002	**0.3544±0.003**
	Acc@5	0.0156	0.4542	0.0209	0.0211	0.1771	0.1757	0.2291	0.1541	0.0741	0.0908	0.4344±0.003	0.4762±0.004	**0.4985±0.001**
	Acc@10	0.0844	0.5083	0.0899	0.0381	0.2146	0.2109	0.2746	0.2048	0.1101	0.1362	0.4794±0.002	0.5176±0.004	**0.5267±0.002**
	MAP	0.0274	0.2608	0.0285	0.0268	0.1489	0.1416	0.1843	0.1156	0.0621	0.0758	0.3594±0.001	0.3948±0.002	**0.4249±0.002**
SE-4	Acc@1	0.0000	0.0856	0.0000	0.0140	0.1423	0.1341	0.1652	0.0830	0.0359	0.0460	0.2798±0.001	0.3047±0.001	**0.3329±0.002**
	Acc@5	0.0274	0.4405	0.0274	0.0209	0.2027	0.2035	0.2558	0.1830	0.1022	0.1329	0.4222±0.002	0.4565±0.002	**0.4757±0.002**
	Acc@10	0.0439	0.4912	0.0439	0.0341	0.2317	0.2363	0.2923	0.2326	0.1414	0.1870	0.4634±0.002	0.4955±0.002	**0.5064±0.002**
	MAP	0.0192	0.2323	0.0200	0.0264	0.1743	0.1709	0.2116	0.1355	0.0743	0.0948	0.3492±0.001	0.3780±0.001	**0.4018±0.002**

FIG. 8B

		TOP	U-TOP	TAXI	MF	RNN	GRU	LSTM	HST-LSTM	STGN	STGCN	LSTPM	LSTPM-OD	STOD-PPA
SE-5	Acc@1	0.0000	0.1063	0.0000	0.0123	0.1065	0.0940	0.1249	0.0546	0.0242	0.0286	0.2507±0.001	0.2739±0.001	0.3049±0.002
	Acc@5	0.0679	0.3985	0.0699	0.0219	0.1603	0.1537	0.2087	0.1361	0.0858	0.0972	0.3847±0.002	0.4184±0.003	0.4433±0.003
	Acc@10	0.1050	0.4583	0.1055	0.0365	0.1910	0.1890	0.2498	0.1818	0.1323	0.1405	0.4333±0.003	0.4617±0.003	0.4732±0.003
	MAP	0.0392	0.2297	0.0409	0.0265	0.1385	0.1278	0.1705	0.1010	0.0638	0.0714	0.3185±0.001	0.3453±0.001	0.3726±0.002
SE-6	Acc@1	0.1278	0.1093	0.1278	0.0078	0.0981	0.0830	0.1291	0.0653	0.0865	0.0998	0.2369±0.001	0.2568±0.001	0.2863±0.003
	Acc@5	0.1769	0.3599	0.1775	0.0153	0.1760	0.1721	0.2405	0.1539	0.1795	0.1854	0.3942±0.004	0.4234±0.003	0.4647±0.004
	Acc@10	0.1769	0.4411	0.1782	0.0331	0.2256	0.2130	0.2933	0.2077	0.2262	0.2366	0.4588±0.003	0.4814±0.004	0.5127±0.004
	MAP	0.1567	0.2161	0.1574	0.0233	0.1418	0.1283	0.1876	0.1171	0.1368	0.1485	0.3161±0.001	0.3395±0.002	0.3706±0.002
SE-7	Acc@1	0.0257	0.0719	0.0257	0.0124	0.0948	0.0869	0.1078	0.0586	0.0206	0.0313	0.2231±0.001	0.2407±0.001	0.2709±0.001
	Acc@5	0.0838	0.3638	0.0838	0.0202	0.1318	0.1304	0.1639	0.1245	0.0563	0.0833	0.3297±0.002	0.3663±0.002	0.3895±0.001
	Acc@10	0.1026	0.4106	0.1096	0.0305	0.1544	0.1577	0.1937	0.1614	0.0814	0.1209	0.3667±0.003	0.4012±0.002	0.4148±0.002
	MAP	0.0521	0.1902	0.0539	0.0234	0.1166	0.1120	0.1398	0.0954	0.0455	0.0643	0.2774±0.001	0.3022±0.001	0.3289±0.001

FIG. 8C

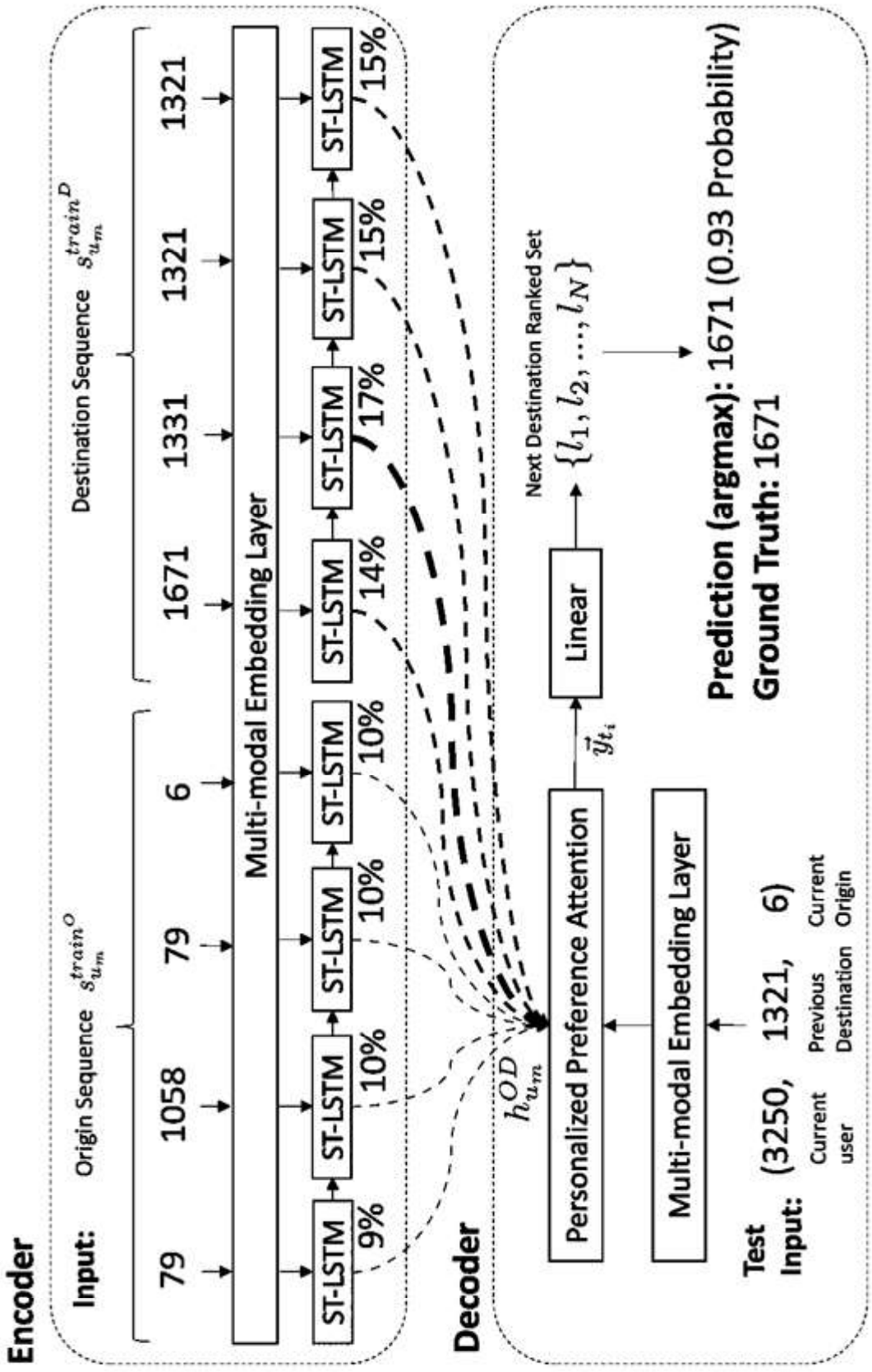

Encoder
Input:
Origin Sequence $s_{u_m}^{train^O}$
Destination Sequence $s_{u_m}^{train^D}$
79
1058
79
6
1671
1331
1321
1321
Multi-modal Embedding Layer
ST-LSTM
9%
10%
10%
10%
14%
17%
15%
15%
Decoder
$h_{u_m}^{OD}$
Personalized Preference Attention
$\vec{y}_{t_i}$
Linear
Next Destination Ranked Set
$\{l_1, l_2, ..., l_N\}$
Multi-modal Embedding Layer
Test Input: (3250, 1321, 6)
Current user
Previous Destination
Current Origin
Prediction (argmax): 1671 (0.93 Probability)
Ground Truth: 1671

FIG. 9