LDBC

*The graph & RDF
benchmark reference*

Full Disclosure Report
of the LDBC Social Network Benchmark

An Implementation of the LDBC Social Network Benchmark's
Interactive Workload over the Graph Engine Service (GES)

September 16, 2024

GENERAL TERMS

Executive Summary

This audit was conducted using the LDBC Social Network Benchmark's Interactive workload on the Graph Engine Service (GES), a proprietary graph database product developed by Huawei. GES supports the property graph model and the Cypher graph query language.

In this audit, the single-node setup for the database was used with the database running on one instance and the benchmark driver running on a separate instance. The benchmark environment was deployed on the Huawei Cloud infrastructure. The system under test and the driver communicated using HTTP REST calls. The benchmark was conducted on scale factors SF30, SF100, and SF300. GES achieved throughputs between 37 775 and 45 432 operations per second.

We would like to highlight that these are the first audited LDBC Social Network Benchmark results that were achieved using the declarative property graph query language, Cypher. Previous implementations used either imperative languages (e.g. C++ and Java) or SPARQL.

Declaration of Audit Success

This report contains an audited LDBC benchmark run. The results have been gathered by an independent and impartial auditor who has validated the implementation of the queries, successfully run the ACID tests associated with the claimed isolation level, read-commited, and verified the overall system's configuration conformance to the description of the benchmark and its strict requirements.
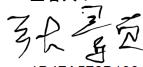
David Püroja   9/17/2024

Mr. David Püroja   Date
(Auditor)
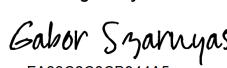
Gabor Szarnyas   9/16/2024

Dr. Gábor Szárnyas   Date
(Head of LDBC SNB Task Force)

Hao Zhang

Dr. Hao Zhang   Date
(Test Sponsor Representative)

Table of Contents

1 System Description and Pricing Summary

1.1 Details of machines driving and running the workload

1.1.1 Machine overview

The machine details were provided by Huawei Cloud.

Table 1.1: Machine Type and Location

Cloud provider	Huawei Cloud Services
Machine region	Beijing 4, availability zone 1
Common name of the item	`ac8.48xlarge.4`
Operating system	20.04.6-Ubuntu

This benchmark used two `ac8.48xlarge.4` instances, one for the driver and one for the SUT. This is shown in Figure 1.1.
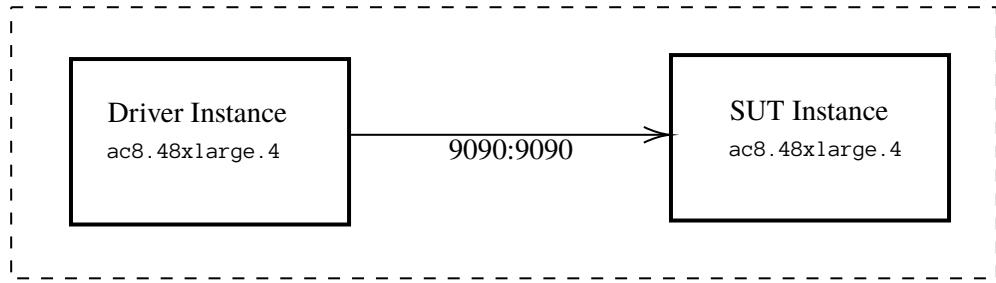
Figure 1.1: Overview of benchmark setup

1.1.2 CPU details

The details below were obtained using the command `cat /proc/cpuinfo` (Listing A.1) issued from the machine instance and the datasheet of the used CPU type.

Table 1.2: CPU details summary

Type	AMD ®
CPU Family	25
Model	17
Total number	1
Cores per CPU	96
Threads per CPU	192
CPU clock frequency	2.40GHz
Total cache size per CPU	L1d cache: 3 MiB L1i cache: 3 MiB L2 cache: 96 MiB L3 cache: 384 MiB

1.1.3 Memory details

The total size of the memory installed is 768GiB and the type of memory is DDR4. This information was obtained using the `sudo lshw -c memory` command (Listing A.2) issued from the virtual machine instance.

1.1.4   Disk and storage details

The disk controller and motherboard types were not obtainable from the virtual machine instance. The storage consists of 1 x 1536GB Extreme SSD (configured as data disk), formatted with `ext4` filesystem and 1 x 345GB General Purpose SSD (configured as system disk). The storage size and type is from the Huawei Cloud Services website.[1]

The 4KB QD1 write performance was measured with the `fio` command on the data disk and the output showed an average of 818.90 IOPS (Listing A.4).

1.1.5   Network details

The benchmark was run using two `ac8.48xlarge.4` instances. The `ac8.48xlarge.4` instances use the virtual Red Hat network adapter. This information was obtained using the `lshw –class network` command (Listing A.3).

1.1.6   Machine pricing

The system pricing summary is included in the table below. The pricing of the Huawei Cloud machine instance is the price for a 3×1-year reserved dedicated instance machine without upfront payment.[2] The license fee for the GES database includes 24/7 enterprise support.

Table 1.3: Pricing summary

Item	Price
`ac8.48xlarge.4` reserved instance machine in Huawei Cloud (standard 3-year term)	425 819 RMB
License fee including 24/7 enterprise support fee (3-year term)	2 680 000 RMB
Total cost of ownership	3 105 819 RMB

1.1.7   System availability

The latest software version of the Graph Engine Service (GES), version 3.0.0, was made available on 2 August, 2024. This version was deployed to the machine described in this section.

---

[1]`https://support.huaweicloud.com/intl/en-us/productdesc-evs/en-us_topic_0014580744.html` (accessed: September 8, 2024).

[2]`https://www.huaweicloud.com/intl/en-us/pricing/calculator.html#/ecs` (accessed: September 8, 2024).

2 DATASET GENERATION

2.1 General information

The Datagen configuration for SF10 is shown in Listing 2.1. The configurations for SF30, SF100 and SF300 are shown in Listings A.5–A.7.

Listing 2.1: Contents of `params-sf10.ini` used for scale factor 10

```
1  ldbc.snb.datagen.generator.scaleFactor:snb.interactive.10
2  ldbc.snb.datagen.serializer.outputDir:/disk/data/SF10
3  ldbc.snb.datagen.serializer.numUpdatePartitions:48
4
5  ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
       activity.CsvCompositeDynamicActivitySerializer
6  ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
       CsvCompositeDynamicPersonSerializer
7  ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.
       CsvCompositeStaticSerializer
8
9  ldbc.snb.datagen.serializer.dateFormatter:ldbc.snb.datagen.util.formatter.LongDateFormatter
```

2.2 Data loading and data schema

The output produced by the Datagen is pre-processed by a Python script to add the Person-knows-Person edges with swapped person ids as the edges are bi-directional. Then, the data is loaded into the database by bulk-loading the CSV files (see Listing A.8) using the schema defined in the `schema.json` (see Listing A.9).

Listing 2.2: Excerpt from `shcema.json`, describing the data schema

```
1  {
2      "type_id": 2,
3      "type_name": "COMMENT",
4      "properties": [
5        {
6          "property_id": 0,
7          "property_name": "id",
8          "property_type": {
9            "primitive_type": "INT64"
10         }
11       },
12       {
13         "property_id": 1,
14         "property_name": "creationDate",
15         "property_type": {
16           "date": "date"
17         }
18       },
19       {
20         "property_id": 2,
21         "property_name": "locationIP",
22         "property_type": {
23           "varchar": {
24             "max_length": 40
25           }
26         }
27       },
28       {
29         "property_id": 3,
30         "property_name": "browserUsed",
31         "property_type": {
32           "varchar": {
33             "max_length": 40
34           }
35         }
36       },
37       {
38         "property_id": 4,
39         "property_name": "content",
40         "property_type": {
41           "varchar": {
42             "max_length": 2000
43           }
44         }
45       },
46       {
47         "property_id": 5,
48         "property_name": "length",
49         "property_type": {
50           "primitive_type": "INT32"
51         }
52       }
53     ],
54     "primary_keys": [
55         "id"
56     ]}
```

Data loading times are shown for each scale factor in the table below. Values were observed by executing the startup command of the SUT with timestamps from `moreutils` in the format `| ts '[\%Y-\%m-\%d \%H:\%M:\%S]'` and measuring the time between starting the service and when the service reported successful startup. The column **Loading time** contains the sum of the CSV loading and data preprocessing times.

Table 2.1: Data loading times

Scale factor	Loading time (s)
30	73
100	282
300	884

3 TEST DRIVER DETAILS

The software versions used are described below as well as the amount of read and write threads used by the driver.

Table 3.1: Summary of test artifacts and main configuration parameters

Driver version	v1.2.0	`https://github.com/ldbc/ldbc_snb_interactive_driver/releases/tag/v1.2.0`
Implementations version	v1.0.0	`https://github.com/ldbc/ldbc_snb_interactive_impls/releases/tag/1.0.0`
LDBC SNB specification version	v0.3.6	`https://arxiv.org/pdf/2001.02299v3.pdf`
Driver read threads	128	
Driver write threads	48	

3.1 Driver implementation

A test driver adaptation for the SUT was provided by the test sponsor and is available as part of the attachment package. The archive created from the version of the driver used for the audited run is included in the attachments of this report.

The SUT-specific test driver class `org.ldbcouncil.snb.impls.workloads.ges.interactive.GesInteractiveDb` extends the class `org.ldbcouncil.driver.Db` provided in the LDBC SNB Interactive driver package. Internally, the `GesInteractiveDb` relies on REST calls (HTTP) to communicate with the SUT.

3.2 Benchmark configuration

The driver applied time compression ratio (TCR) values of

- TCR = 0.0010 for scale factor 30,
- TCR = 0.0029 for scale factor 100,
- TCR = 0.0114 for scale factor 300.

The complete configuration files are shown in Listings A.10–A.12 and are also included in the attached supplementary materials.

4 PERFORMANCE METRICS

The performance metrics reported here show benchmark runs with scale factors 30, 100 and 300. In each case, the query on-time compliance is higher than the minimum required 95%. The performance summary tables below highlight key performance characteristics.

Table 4.1: Summary of results for scale factor 30

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
02h 01m 18s	274 968 913	37 775.91 $\frac{operations}{second}$	100%

Table 4.2: Summary of results for scale factor 100

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
02h 06m 48s	345 675 524	45 432.22 $\frac{operations}{second}$	98.45%

Table 4.3: Summary of results for scale factor 300

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
02h 03m 54s	299 967 535	40 347.04 $\frac{operations}{second}$	98.68%

During the benchmark run, the query executions shown in the tables below were observed using the different scale factors. Columns (except for Query and Total count) are showing duration values with microsecond (μs) precision. The notation $\mathbf{P_i}$ is used for the ith percentile among all observed execution run times of a given query type. After each benchmark result table a table with the percentage of late operations per query type is shown.

Table 4.4: Detailed performance benchmark results for scale factor 30 in microseconds

Query	Total count	Min.	Max.	Mean	P_{50}	P_{90}	P_{95}	P_{99}
Query1	1 794 516	9 380	215 640	21 049.85	21 143	24 305	25 210	27 098
Query2	1 261 011	1 618	60 442	3 477.62	3 468	3 943	4 177	5 011
Query3	440 165	25 869	121 932	46 309.80	46 062	53 338	55 490	61 356
Query4	1 296 039	5 504	80 016	14 340.83	14 236	17 226	18 170	20 282
Query5	648 019	25 718	176 584	71 115.95	69 908	92 708	97 884	106 936
Query6	147 650	1 423	58 524	8 223.88	8 173	14 724	16 032	19 042
Query7	972 029	148	57 936	522.60	353	898	1 393	2 910
Query8	5 184 156	824	63 132	2 408.86	2 023	3 969	4 588	5 656
Query9	121 503	267 952	629 536	451 036.95	454 432	503 584	513 616	533 504
Query10	1 261 011	18 993	189 968	51 083.72	49 062	67 356	74 768	91 288
Query11	2 332 871	631	60 778	1 574.28	1 497	1 953	2 247	3 153
Query12	1 060 395	10 248	99 180	29 876.39	29 025	39 894	43 410	50 700
Query13	2 455 653	169	60 032	540.35	422	837	1 410	1 957
Query14	952 192	337	435 712	12 143.71	2 687	5 551	112 228	213 000
ShortQuery1PersonProfile	25 014 991	119	60 832	296.66	202	379	931	1 743
ShortQuery2PersonPosts	25 014 991	127	59 970	510.09	390	900	1 318	2 028
ShortQuery3PersonFriends	25 014 991	125	54 644	676.11	464	1 436	2 092	3 180
ShortQuery4MessageContent	25 013 798	117	56 044	301.56	209	384	928	1 728
ShortQuery5MessageCreator	25 013 798	117	53 168	286.07	194	368	921	1 700
ShortQuery6MessageForum	25 013 798	121	53 924	291.88	204	378	910	1 660
ShortQuery7MessageReplies	25 013 798	116	61 514	306.33	224	402	906	1 652
Update1AddPerson	14 260	613	47 388	1 164.57	889	1 957	2 155	2 882
Update2AddPostLike	11 537 022	449	59 970	761.05	630	1 130	1 547	2 289
Update3AddCommentLike	12 202 767	455	54 228	756.57	629	1 108	1 522	2 273
Update4AddForum	255 854	493	41 740	815.42	666	1 280	1 688	2 418
Update5AddForumMembership	42 157 230	447	62 318	763.43	631	1 142	1 557	2 301
Update6AddPost	3 301 814	482	57 600	851.34	701	1 410	1 736	2 402
Update7AddComment	9 453 070	480	59 080	861.96	702	1 436	1 753	2 499
Update8AddFriendship	1 019 521	477	47 284	772.37	637	1 155	1 581	2 312

Performance Metrics

Table 4.5: Detailed query on time results for scale factor 30

Query	Total count	Total late count	Late count percentage
Query1	1 794 516	0	0.00
Query2	1 261 011	0	0.00
Query3	440 165	0	0.00
Query4	1 296 039	0	0.00
Query5	648 019	0	0.00
Query6	147 650	0	0.00
Query7	972 029	0	0.00
Query8	5 184 156	0	0.00
Query9	121 503	0	0.00
Query10	1 261 011	0	0.00
Query11	2 332 871	0	0.00
Query12	1 060 395	0	0.00
Query13	2 455 653	0	0.00
Query14	952 192	0	0.00
ShortQuery1PersonProfile	25 014 991	0	0.00
ShortQuery2PersonPosts	25 014 991	0	0.00
ShortQuery3PersonFriends	25 014 991	0	0.00
ShortQuery4MessageContent	25 013 798	0	0.00
ShortQuery5MessageCreator	25 013 798	0	0.00
ShortQuery6MessageForum	25 013 798	0	0.00
ShortQuery7MessageReplies	25 013 798	0	0.00
Update1AddPerson	14 260	0	0.00
Update2AddPostLike	11 537 022	0	0.00
Update3AddCommentLike	12 202 767	0	0.00
Update4AddForum	255 854	0	0.00
Update5AddForumMembership	42 157 230	0	0.00
Update6AddPost	3 301 814	0	0.00
Update7AddComment	9 453 070	0	0.00
Update8AddFriendship	1 019 521	0	0.00
Total	274 968 913	0	0.00

Table 4.6: Detailed performance benchmark results for scale factor 100 in microseconds

Query	Total count	Min.	Max.	Mean	P_{50}	P_{90}	P_{95}	P_{99}
Query1	2 096 328	286	450 912	47 210.84	47 686	57 300	59 788	64 256
Query2	1 473 095	163	165 608	5 041.66	4 983	6 128	6 394	6 946
Query3	443 126	70 404	350 544	124 962.64	124 884	140 168	145 896	161 728
Query4	1 514 014	1 634	240 856	18 463.34	18 293	23 113	24 528	27 330
Query5	698 776	2 262	306 352	96 220.09	96 836	122 308	127 972	137 088
Query6	125 586	1 822	140 176	14 878.89	9 103	28 045	30 301	34 874
Query7	1 434 329	151	81 132	1 012.84	948	1 801	2 111	3 535
Query8	10 900 901	137	118 652	908.78	884	1 643	1 853	2 334
Query9	103 424	207	1 049 024	705 018.52	705 120	804 736	826 720	863 680
Query10	1 362 612	469	294 672	66 859.95	65 506	86 176	93 240	108 140
Query11	2 477 477	378	114 772	2 520.24	2 461	3 415	3 667	4 207
Query12	1 238 739	182	201 208	38 036.96	37 258	50 270	54 554	65 132
Query13	2 868 658	188	78 268	1 251.75	1 214	2 205	2 547	3 158
Query14	1 112 337	310	495 072	37 857.76	3 790	132 400	154 256	203 248
ShortQuery1PersonProfile	34 961 435	119	109 584	793.64	778	1 509	1 717	2 209
ShortQuery2PersonPosts	34 961 435	132	126 184	1 055.14	1 021	1 838	2 111	2 820
ShortQuery3PersonFriends	34 961 435	124	118 676	1 311.52	1 158	2 323	3 103	4 777
ShortQuery4MessageContent	34 961 199	120	104 528	799.43	786	1 511	1 718	2 207
ShortQuery5MessageCreator	34 961 199	119	105 928	780.40	765	1 490	1 696	2 178
ShortQuery6MessageForum	34 961 199	120	103 708	788.97	772	1 501	1 706	2 182
ShortQuery7MessageReplies	34 961 199	117	109 672	805.61	787	1 520	1 726	2 198
Update1AddPerson	13 859	624	62 764	1 695.62	1 597	2 699	3 104	3 864
Update2AddPostLike	10 221 554	466	105 820	1 299.58	1 286	2 048	2 294	2 938
Update3AddCommentLike	15 493 541	460	114 780	1 304.79	1 295	2 051	2 297	2 938
Update4AddForum	240 549	509	65 362	1 343.14	1 311	2 126	2 412	3 139
Update5AddForumMembership	31 891 602	455	115 888	1 297.52	1 281	2 049	2 296	2 941
Update6AddPost	3 308 433	490	98 640	1 420.13	1 393	2 229	2 543	3 274
Update7AddComment	10 824 015	477	118 616	1 431.70	1 417	2 217	2 519	3 246
Update8AddFriendship	1 103 468	480	100 616	1 296.65	1 268	2 061	2 318	2 990

Performance Metrics

Table 4.7: Detailed query on time results for scale factor 100

Query	Total count	Total late count	Late count percentage
Query1	2 096 328	402 830	19.22
Query10	1 362 612	261 840	19.22
Query11	2 477 477	476 073	19.22
Query12	1 238 739	238 037	19.22
Query13	2 868 658	551 242	19.22
Query14	1 112 337	213 746	19.22
Query2	1 473 095	283 071	19.22
Query3	443 126	85 152	19.22
Query4	1 514 014	290 934	19.22
Query5	698 776	134 277	19.22
Query6	125 586	24 133	19.22
Query7	1 434 329	275 622	19.22
Query8	10 900 901	2 094 718	19.22
Query9	103 424	19 873	19.22
ShortQuery1PersonProfile	34 961 435	0	0.00
ShortQuery2PersonPosts	34 961 435	0	0.00
ShortQuery3PersonFriends	34 961 435	0	0.00
ShortQuery4MessageContent	34 961 199	0	0.00
ShortQuery5MessageCreator	34 961 199	0	0.00
ShortQuery6MessageForum	34 961 199	0	0.00
ShortQuery7MessageReplies	34 961 199	0	0.00
Update1AddPerson	13 859	0	0.00
Update2AddPostLike	10 221 554	0	0.00
Update3AddCommentLike	15 493 541	0	0.00
Update4AddForum	240 549	0	0.00
Update5AddForumMembership	31 891 602	0	0.00
Update6AddPost	3 308 433	0	0.00
Update7AddComment	10 824 015	0	0.00
Update8AddFriendship	1 103 468	0	0.00
Total	345 675 524	5 351 548	1.55

Performance Metrics

Table 4.8: Detailed performance benchmark results for scale factor 300 in microseconds

Query	Total count	Min.	Max.	Mean	P_{50}	P_{90}	P_{95}	P_{99}
Query1	1 474 688	387	1 053 568	95 084.58	96 344	114 132	118 752	127 380
Query2	1 036 267	163	318 528	5 518.54	5 558	6 772	7 083	7 729
Query3	270 014	1 023	1 522 944	363 698.03	362 064	399 232	425 024	475 952
Query4	1 065 053	1 440	440 048	23 743.19	23 643	29 532	31 304	35 034
Query5	456 451	167	592 768	124 088.87	129 464	162 312	169 136	180 640
Query6	66 107	2 052	285 088	27 063.10	10 791	55 436	60 426	71 436
Query7	1 198 184	155	134 176	1 210.72	1 162	2 029	2 388	3 908
Query8	12 780 625	140	202 784	1 095.63	1 101	1 856	2 108	2 696
Query9	54 386	175	1 467 200	904 031.88	913 504	1 090 368	1 124 288	1 178 944
Query10	871 406	533	987 296	78 734.46	77 580	104 232	112 660	131 424
Query11	1 597 578	351	205 624	3 157.90	3 119	4 140	4 448	5 121
Query12	871 406	193	454 560	42 010.39	41 290	59 922	65 316	76 400
Query13	2 017 994	206	201 528	1 825.89	1 718	3 022	3 438	4 201
Query14	782 487	415	3 266 816	52 415.70	5 681	137 184	158 864	219 360
ShortQuery1PersonProfile	30 806 153	123	240 688	985.16	995	1 727	1 974	2 550
ShortQuery2PersonPosts	30 806 153	131	202 200	1 288.14	1 260	2 123	2 447	3 242
ShortQuery3PersonFriends	30 806 153	131	242 488	1 618.12	1 449	2 732	3 630	5 563
ShortQuery4MessageContent	30 807 424	125	240 768	994.98	1 004	1 735	1 982	2 560
ShortQuery5MessageCreator	30 807 424	121	202 584	969.55	980	1 705	1 949	2 516
ShortQuery6MessageForum	30 807 424	121	201 520	980.81	991	1 720	1 965	2 532
ShortQuery7MessageReplies	30 807 424	119	238 912	999.85	1 009	1 743	1 989	2 557
Update1AddPerson	8 696	642	159 568	2 030.13	1 851	3 038	3 416	4 370
Update2AddPostLike	8 209 665	450	200 648	1 455.43	1 437	2 277	2 566	3 284
Update3AddCommentLike	16 185 127	460	238 240	1 449.64	1 431	2 271	2 559	3 272
Update4AddForum	148 619	508	201 344	1 560.68	1 531	2 393	2 714	3 475
Update5AddForumMembership	20 455 562	456	211 280	1 493.23	1 475	2 302	2 593	3 314
Update6AddPost	2 459 613	505	201 368	1 634.57	1 574	2 557	2 910	3 722
Update7AddComment	11 538 459	482	239 144	1 474.24	1 428	2 370	2 696	3 453
Update8AddFriendship	770 993	472	137 968	1 515.41	1 492	2 333	2 632	3 373

Table 4.9: Detailed query on time results for scale factor 300

Query	Total count	Total late count	Late count percentage
Query1	1 474 688	238 397	16.17
Query2	1 036 267	167 521	16.17
Query3	270 014	43 642	16.16
Query4	1 065 053	172 155	16.16
Query5	456 451	73 770	16.16
Query6	66 107	10 684	16.16
Query7	1 198 184	193 702	16.17
Query8	12 780 625	2 066 284	16.17
Query9	54 386	8 802	16.18
Query10	871 406	140 879	16.17
Query11	1 597 578	258 239	16.16
Query12	871 406	140 877	16.17
Query13	2 017 994	326 231	16.17
Query14	782 487	126 475	16.16
ShortQuery1PersonProfile	30 806 153	0	0.00
ShortQuery2PersonPosts	30 806 153	0	0.00
ShortQuery3PersonFriends	30 806 153	0	0.00
ShortQuery4MessageContent	30 807 424	0	0.00
ShortQuery5MessageCreator	30 807 424	0	0.00
ShortQuery6MessageForum	30 807 424	0	0.00
ShortQuery7MessageReplies	30 807 424	0	0.00
Update1AddPerson	8 696	0	0.00
Update2AddPostLike	8 209 665	0	0.00
Update3AddCommentLike	16 185 127	0	0.00
Update4AddForum	148 619	0	0.00
Update5AddForumMembership	20 455 562	0	0.00
Update6AddPost	2 459 613	0	0.00
Update7AddComment	11 538 459	0	0.00
Update8AddFriendship	770 993	0	0.00
Total	299 967 535	3 967 658	1.32

5 Validation of the Results

The scale factor 10 data set was used for validating the correctness of the implementation over the SUT. The validation data set with 150 038 entries was created with the SNB Interactive reference implementation over Neo4j, which can be download from the LDBC Cloudflare R2 bucket[1]. The system with the driver configuration shown in Listing A.13 successfully returned the expected result sets for the queries of the benchmark.

---

[1] `https://pub-383410a98aef4cb686f0c7601eddd25f.r2.dev/interactive-v1/validation_params-sf0.1-sf10.tar.zst`

6 ACID Compliance

6.1 Transaction isolation level

The benchmark was executed using the *Read committed* isolation level setting of the SUT, which conforms to the minimum isolation level required by the SNB Interactive specification.

6.2 SNB Interactive ACID test results

The ACID test implementations were reviewed to conform to the ACID test specifications, with all specified test cases implemented. Furthermore, test execution was successful, passing the tests required for the *read committed* isolation level.

6.3 Recovery and durability

6.3.1 Recovery

Durability tests were run using the regular benchmark workload with scale factor 30, starting at 19:51 UTC. Both server machines where shutdown using the command sudo shutdown -rf 21:51, forced rebooting (ungracefully) both machines 2 hours after start of the benchmark, with 14 917 completed operations. The database server process was manually started again after the crash and it was ready in 17 seconds.

6.3.2 Durability

From the driver log, the last update operations before the crash were obtained using the commands below.

```
1  $ grep LdbcUpdate1 LDBC-SNB-results_log.csv | tail -n 1
2  LdbcUpdate1AddPerson|1725313859128|1725313859128|974|0|1354462622429
3  $ grep LdbcUpdate2 LDBC-SNB-results_log.csv | tail -n 1
4  LdbcUpdate2AddPostLike|1725313860094|1725313860094|537|0|1354463587852
5  $ grep LdbcUpdate3 LDBC-SNB-results_log.csv | tail -n 1
6  LdbcUpdate3AddCommentLike|1725313860094|1725313860094|618|0|1354463588048
7  $ grep LdbcUpdate4 LDBC-SNB-results_log.csv | tail -n 1
8  LdbcUpdate4AddForum|1725313860063|1725313860063|730|0|1354463557498
9  $ grep LdbcUpdate5 LDBC-SNB-results_log.csv | tail -n 1
10 LdbcUpdate5AddForumMembership|1725313860094|1725313860094|559|0|1354463587957
11 $ grep LdbcUpdate6 LDBC-SNB-results_log.csv | tail -n 1
12 LdbcUpdate6AddPost|1725313860083|1725313860088|760|0|1354463577740
13 $ grep LdbcUpdate7 LDBC-SNB-results_log.csv | tail -n 1
14 LdbcUpdate7AddComment|1725313860094|1725313860094|691|0|1354463588802
15 $ grep LdbcUpdate8 LDBC-SNB-results_log.csv | tail -n 2
16 LdbcUpdate8AddFriendship|1725313860094|1725313860094|598|0|1354463589300
17 LdbcUpdate8AddFr
```

The log entries include the operation name, actual and scheduled start time, the execution time, the delay between scheduled and actual start times, and the initial query start time without the total compression ratio multiplier (which is shown in the last column). From the logs, the last completed updates were retrieved for each update. For the last update, the entry was incomplete due to the driver stopping while writing the log. The corresponding update was retrieved by taking the last complete update entry from the driver logs and using the CSV update streams to fetch the update. The query parameters were obtained from the initial CSV files generated by the Datagen using the initial query start time and the type number of the operation using the commands below.

```
1  $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354462622429|.*|1|.*'
2  updateStream_0_0_person.csv:13679:1354462622429|0|1|37383395448696|Mircea|Antonescu|male
       |469065600000|1354462622429|77.232.214.229|Firefox|1311|ro;hu;en|Mircea37383395448696@gmail.com;
       Mircea37383395448696@hotmail.com;Mircea37383395448696@yahoo.com
       |139;147;1201;1410;1749;1865;1997;2096;2777;2788;2818;2838;2851;2999;3038;6954;6989;8484;8975;9076;10222;
3      11947|5947,2005|
4  $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354463587852|.*|2|.*'
5  updateStream_0_0_forum.csv:65379755:1354463587852|1336241769567|2|28587302457917|37383501993841|1354463587852
6  $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354463588048|.*|3|.*'
7  updateStream_0_0_forum.csv:65379758:1354463588048|1333211182658|3|28587302359960|37383539570994|1354463588048
8  $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354463557498|.*|4|.*'
9  updateStream_0_0_forum.csv:65379373:1354463557498|1348258936342|4|37383412214128|Album 1 of Dang Dinh Minh
       |1354463557498|35184372184884|5159
10 $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354463587957|.*|5|.*'
11 updateStream_0_0_forum.csv:65379756:1354463587957|1348308858822|5|26388289645681|35184372257211|1354463587957
12 $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354463577740|.*|6|.*'
13 updateStream_0_0_forum.csv:65379640:1354463577740|1327897955456|6|37383437726930||1354463577740|121.79.242.98|
       Chrome|tk|About Cicero, ttempted the government overthrow through an attack on the city from outside forces,
       and Cicero suppressed the revolt by executing five conspirators without due process. During the
       |195|26388279110906|6597078181039|29|1173
14 $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354463588802|.*|7|.*'
15 updateStream_0_0_forum.csv:65379772:1354463588802|1295369582435|7|37383400949452|1354463588802|31.131.241.128|
       Safari|duh|3|13194139709142|81|-1|37383400949450|
16 $ grep -rnw 'social_network-sf30-numpart-1/' -e '1354463590120|.*|8|.*'
17 updateStream_0_0_forum.csv:65379789:1354463590120|1352465017690|8|35184372124848|37383395447296|1354463590120
```

To check whether the graph entities in the driver log entries were persisted in the database, custom read queries were executed after database restart. The queries returned the data that was committed according to the logs, so the system passed this check. These additional test queries are included in the supplementary materials.

7 SUPPLEMENTARY MATERIALS

The table below shows the list of supplementary materials. These materials are made available with this full disclosure report to allow reproducibility of results.

Table 7.1: Supplementary materials

File	Purpose
results-sf{30,100,300}.tar.gz	Driver output files for the selected scale factors
console-output-sf{30,100,300}.txt	Driver console outputs for the selected scale factors
params-sf{10,30,100,300}.ini	Datagen parameters for the used scale factors
huawei_ges_1.0.0_amd64.deb	Linux installer package of database
ges_ldbc_snb	folder containing supplemental package
ges_ldbc_snb/Readme.pdf	Readme for the benchmark package
ges_ldbc_snb/server	Server files (SUT)
ges_ldbc_snb/server/dataconverter.py	Python script to add the knows edges bidirectionally in the personKnowsperson data.
ges_ldbc_snb/server/query_service/schema.json	Schema used
ges_ldbc_snb/server/query_service/bulk_load_path.json	Bulk load configuration
ges_ldbc_snb/server/query_service/config.json	SUT configuration
ges_ldbc_snb/server/query_service/lib	query service libraries
ges_ldbc_snb/server	Server files (SUT)
ges_ldbc_snb/client/durability_test	durability test files
ges_ldbc_snb/client/ges_acid_test	ACID test files
ges_ldbc_snb/client/ges_ldbc_snb_interactive_driver	GES LDBC SNB client implementation

Supplementary Materials

The attachment folder directory structure is as follows:

```
attachments
├── results-sf30.tar.gz
├── results-sf100.tar.gz
├── results-sf300.tar.gz
├── console-output-sf30.txt
├── console-output-sf100.txt
├── console-output-sf300.txt
├── huawei_ges_1.0.0_amd64.deb
├── ges_ldbc_snb
│   ├── Readme.pdf
│   ├── server.zip
│   ├── client.zip
│   ├── prepare_services.py
│   ├── durability_test
│   │   ├── ins1.json
│   │   ├── ins2.json
│   │   ├── ins3.json
│   │   ├── ins4.json
│   │   ├── ins5.json
│   │   ├── ins6.json
│   │   ├── ins7.json
│   │   └── ins8.json
│   └── query_service
│       ├── schema.json
│       └── config
│           └── bulk_load_path.json
├── params-sf10.ini
├── params-sf30.ini
├── params-sf100.ini
└── params-sf300.ini
```

A APPENDIX

A.1 CPU details

Listing A.1: Output of the `cat /proc/cpuinfo` command for one core

```
 1 processor : 0
 2 vendor_id : AuthenticAMD
 3 cpu family : 25
 4 model   : 17
 5 model name  : General Purpose Processor
 6 stepping  : 1
 7 microcode : 0x1000065
 8 cpu MHz   : 2399.996
 9 cache size : 1024 KB
10 physical id : 0
11 siblings  : 96
12 core id   : 0
13 cpu cores : 96
14 apicid    : 0
15 initial apicid  : 0
16 fpu   : yes
17 fpu_exception : yes
18 cpuid level : 16
19 wp    : yes
20 flags   : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush mmx fxsr sse sse2 ht
      syscall nx mmxext fxsr_opt pdpe1gb rdtscp lm constant_tsc rep_good nopl nonstop_tsc cpuid extd_apicid amd_dcm
       tsc_known_freq pni pclmulqdq ssse3 fma cx16 pcid sse4_1 sse4_2 x2apic movbe popcnt tsc_deadline_timer aes
      xsave avx f16c rdrand hypervisor lahf_lm cmp_legacy cr8_legacy abm sse4a misalignsse 3dnowprefetch osvw
      topoext perfctr_core invpcid_single ssbd ibrs ibpb stibp vmmcall fsgsbase tsc_adjust bmi1 avx2 smep bmi2 erms
       invpcid avx512f avx512dq rdseed adx smap avx512ifma clflushopt clwb avx512cd sha_ni avx512bw avx512vl
      xsaveopt xsavec xgetbv1 xsaves avx512_bf16 clzero xsaveerptr wbnoinvd arat avx512vbmi umip avx512_vbmi2 gfni
      vaes vpclmulqdq avx512_vnni avx512_bitalg avx512_vpopcntdq rdpid arch_capabilities
21 bugs    : sysret_ss_attrs null_seg spectre_v1 spectre_v2 spec_store_bypass
22 bogomips  : 4799.99
23 TLB size  : 3584 4K pages
24 clflush size  : 64
25 cache_alignment : 64
26 address sizes : 52 bits physical, 48 bits virtual
27 power management:
```

A.2 Memory details

Listing A.2: Output of the `lshw -c memory` command

```
 1   *-memory
 2       description: System Memory
 3       physical id: 1000
 4       size: 768GiB
 5       capabilities: ecc
 6       configuration: errordetection=multi-bit-ecc
 7     *-bank:0
 8         description: DIMM RAM
 9         vendor: Huawei Cloud
10         physical id: 0
```

```
11        slot: DIMM 0
12        size: 16GiB
```

A.3 Network details

Listing A.3: Output of the `lshw -class network` command

```
1  == CLIENT
2    *-network
3         description: Ethernet controller
4         product: Virtio network device
5         vendor: Red Hat, Inc.
6         physical id: 3
7         bus info: pci@0000:00:03.0
8         version: 00
9         width: 64 bits
10        clock: 33MHz
11        capabilities: msix bus_master cap_list
12        configuration: driver=virtio-pci latency=0
13        resources: irq:0 memory:fd048000-fd04bfff memory:fd000000-fd007fff memory:fd04c000-fd04ffff
14      *-virtio0
15          description: Ethernet interface
16          physical id: 0
17          bus info: virtio@0
18          logical name: eth0
19          serial: fa:16:3e:93:93:46
20          capabilities: ethernet physical
21          configuration: autonegotiation=off broadcast=yes driver=virtio_net driverversion=1.0.0 ip=10.0.0.179
        link=yes multicast=yes
22  == SERVER
23    *-network
24         description: Ethernet controller
25         product: Virtio network device
26         vendor: Red Hat, Inc.
27         physical id: 3
28         bus info: pci@0000:00:03.0
29         version: 00
30         width: 64 bits
31         clock: 33MHz
32         capabilities: msix bus_master cap_list
33         configuration: driver=virtio-pci latency=0
34         resources: irq:0 memory:fd048000-fd04bfff memory:fd000000-fd007fff memory:fd04c000-fd04ffff
35      *-virtio0
36          description: Ethernet interface
37          physical id: 0
38          bus info: virtio@0
39          logical name: eth0
40          serial: fa:16:3e:93:93:7b
41          capabilities: ethernet physical
42          configuration: autonegotiation=off broadcast=yes driver=virtio_net driverversion=1.0.0 ip=10.0.0.232
        link=yes multicast=yes
```

Listing A.4: Output of the `fio` command

```
1  fio --rw=write --ioengine=sync --fdatasync=1 --direct=1 --directory=io-test-data --size=2g --bs=4k --name=iotest
2  iotest: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=sync, iodepth=1
3  fio-3.16
4  Starting 1 process
5  iotest: Laying out IO file (1 file / 2048MiB)
6  Jobs: 1 (f=1): [W(1)][100.0%][w=3388KiB/s][w=847 IOPS][eta 00m:00s]
7  iotest: (groupid=0, jobs=1): err= 0: pid=318852: Sun Sep  8 20:25:05 2024
```

```
 8    write: IOPS=818, BW=3276KiB/s (3354kB/s)(2048MiB/640189msec); 0 zone resets
 9      clat (usec): min=279, max=9352, avg=415.99, stdev=147.47
10       lat (usec): min=279, max=9352, avg=416.04, stdev=147.47
11      clat percentiles (usec):
12       |  1.00th=[  302],  5.00th=[  310], 10.00th=[  318], 20.00th=[  326],
13       | 30.00th=[  338], 40.00th=[  367], 50.00th=[  400], 60.00th=[  416],
14       | 70.00th=[  429], 80.00th=[  445], 90.00th=[  502], 95.00th=[  644],
15       | 99.00th=[ 1045], 99.50th=[ 1188], 99.90th=[ 1598], 99.95th=[ 1844],
16       | 99.99th=[ 3064]
17     bw (  KiB/s): min= 2928, max= 3544, per=100.00%, avg=3275.61, stdev=89.25, samples=1280
18     iops        : min=  732, max=  886, avg=818.90, stdev=22.31, samples=1280
19    lat (usec)   : 500=89.98%, 750=6.68%, 1000=2.12%
20    lat (msec)   : 2=1.18%, 4=0.03%, 10=0.01%
21    fsync/fdatasync/sync_file_range:
22      sync (usec): min=638, max=11993, avg=804.46, stdev=183.96
23      sync percentiles (usec):
24       |  1.00th=[  685],  5.00th=[  701], 10.00th=[  709], 20.00th=[  725],
25       | 30.00th=[  734], 40.00th=[  742], 50.00th=[  750], 60.00th=[  766],
26       | 70.00th=[  783], 80.00th=[  824], 90.00th=[  938], 95.00th=[ 1139],
27       | 99.00th=[ 1516], 99.50th=[ 1729], 99.90th=[ 2278], 99.95th=[ 2868],
28       | 99.99th=[ 5145]
29    cpu          : usr=0.28%, sys=1.16%, ctx=1048593, majf=0, minf=13
30    IO depths    : 1=200.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
31       submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
32       complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
33       issued rwts: total=0,524288,0,0 short=524287,0,0,0 dropped=0,0,0,0
34       latency   : target=0, window=0, percentile=100.00%, depth=1
35
36  Run status group 0 (all jobs):
37    WRITE: bw=3276KiB/s (3354kB/s), 3276KiB/s-3276KiB/s (3354kB/s-3354kB/s), io=2048MiB (2147MB), run=640189-640189
         msec
38
39  Disk stats (read/write):
40    vdb: ios=0/1572792, merge=0/1048581, ticks=0/619466, in_queue=480, util=100.00%
```

A.4   Datagen configuration

Listing A.5: Contents of `params-sf30.ini` used for scale factor 30

```
1  ldbc.snb.datagen.generator.scaleFactor:snb.interactive.10
2  ldbc.snb.datagen.serializer.outputDir:/disk/data/SF10
3  ldbc.snb.datagen.serializer.numUpdatePartitions:48
4
5  ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
       activity.CsvCompositeDynamicActivitySerializer
6  ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
       CsvCompositeDynamicPersonSerializer
7  ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.
       CsvCompositeStaticSerializer
8
9  ldbc.snb.datagen.serializer.dateFormatter:ldbc.snb.datagen.util.formatter.LongDateFormatter
```

Listing A.6: Contents of `params-sf100.ini` used for scale factor 100

```
1  ldbc.snb.datagen.generator.scaleFactor:snb.interactive.10
2  ldbc.snb.datagen.serializer.outputDir:/disk/data/SF10
```

```
3  ldbc.snb.datagen.serializer.numUpdatePartitions:48
4
5  ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
       activity.CsvCompositeDynamicActivitySerializer
6  ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
       CsvCompositeDynamicPersonSerializer
7  ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.
       CsvCompositeStaticSerializer
8
9  ldbc.snb.datagen.serializer.dateFormatter:ldbc.snb.datagen.util.formatter.LongDateFormatter
```

Listing A.7: Contents of `params-sf300.ini` used for scale factor 300

```
1  ldbc.snb.datagen.generator.scaleFactor:snb.interactive.10
2  ldbc.snb.datagen.serializer.outputDir:/disk/data/SF10
3  ldbc.snb.datagen.serializer.numUpdatePartitions:48
4
5  ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
       activity.CsvCompositeDynamicActivitySerializer
6  ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
       CsvCompositeDynamicPersonSerializer
7  ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.
       CsvCompositeStaticSerializer
8
9  ldbc.snb.datagen.serializer.dateFormatter:ldbc.snb.datagen.util.formatter.LongDateFormatter
```

A.5   Import configuration

Listing A.8: Content of `bulk_load_path.json` bulk load configuration

```
1  {
2      "loading_config": {
3        "data_source": {
4          "scheme": "file",
5          "location": "path/social_network"
6        },
7        "import_option": "init",
8        "format": {
9          "type": "csv",
10         "metadata": {
11            "delimiter": "|"
12         }
13        }
14     },
15     "vertex_mappings": [
16        {
17          "type_name": "PLACE",
18          "inputs": [
19            "static/place_0_0.csv"
20          ]
21        },
22        {
23          "type_name": "PERSON",
24          "inputs": [
25            "dynamic/person_0_0.csv"
26          ]
```

```
27        },
28        {
29          "type_name": "COMMENT",
30          "inputs": [
31            "dynamic/comment_0_0.csv"
32          ]
33        },
34        {
35          "type_name": "POST",
36          "inputs": [
37            "dynamic/post_0_0.csv"
38          ]
39        },
40        {
41          "type_name": "FORUM",
42          "inputs": [
43            "dynamic/forum_0_0.csv"
44          ]
45        },
46        {
47          "type_name": "ORGANISATION",
48          "inputs": [
49            "static/organisation_0_0.csv"
50          ]
51        },
52        {
53          "type_name": "TAGCLASS",
54          "inputs": [
55            "static/tagclass_0_0.csv"
56          ]
57        },
58        {
59          "type_name": "TAG",
60          "inputs": [
61            "static/tag_0_0.csv"
62          ]
63        }
64      ],
65      "edge_mappings": [
66        {
67          "type_triplet": {
68            "edge": "HASCREATOR",
69            "source_vertex": "COMMENT",
70            "destination_vertex": "PERSON"
71          },
72          "inputs": [
73            "dynamic/comment_hasCreator_person_0_0.csv"
74          ],
75          "source_vertex_mappings": [
76            {
77              "column": {
78                "index": 0,
79                "name": "id"
80              }
81            }
82          ],
83          "destination_vertex_mappings": [
84            {
```

```
 85              "column": {
 86                "index": 1,
 87                "name": "id"
 88              }
 89            }
 90          ]
 91        },
 92        {
 93          "type_triplet": {
 94            "edge": "HASCREATOR",
 95            "source_vertex": "POST",
 96            "destination_vertex": "PERSON"
 97          },
 98          "inputs": [
 99            "dynamic/post_hasCreator_person_0_0.csv"
100          ],
101          "source_vertex_mappings": [
102            {
103              "column": {
104                "index": 0,
105                "name": "id"
106              }
107            }
108          ],
109          "destination_vertex_mappings": [
110            {
111              "column": {
112                "index": 1,
113                "name": "id"
114              }
115            }
116          ]
117        },
118        {
119          "type_triplet": {
120            "edge": "HASTAG",
121            "source_vertex": "POST",
122            "destination_vertex": "TAG"
123          },
124          "inputs": [
125            "dynamic/post_hasTag_tag_0_0.csv"
126          ],
127          "source_vertex_mappings": [
128            {
129              "column": {
130                "index": 0,
131                "name": "id"
132              }
133            }
134          ],
135          "destination_vertex_mappings": [
136            {
137              "column": {
138                "index": 1,
139                "name": "id"
140              }
141            }
142          ]
```

```
143 │        },
144 │        {
145 │          "type_triplet": {
146 │            "edge": "REPLYOF",
147 │            "source_vertex": "COMMENT",
148 │            "destination_vertex": "COMMENT"
149 │          },
150 │          "inputs": [
151 │            "dynamic/comment_replyOf_comment_0_0.csv"
152 │          ],
153 │          "source_vertex_mappings": [
154 │            {
155 │              "column": {
156 │                "index": 0,
157 │                "name": "id"
158 │              }
159 │            }
160 │          ],
161 │          "destination_vertex_mappings": [
162 │            {
163 │              "column": {
164 │                "index": 1,
165 │                "name": "id"
166 │              }
167 │            }
168 │          ]
169 │        },
170 │        {
171 │          "type_triplet": {
172 │            "edge": "REPLYOF",
173 │            "source_vertex": "COMMENT",
174 │            "destination_vertex": "POST"
175 │          },
176 │          "inputs": [
177 │            "dynamic/comment_replyOf_post_0_0.csv"
178 │          ],
179 │          "source_vertex_mappings": [
180 │            {
181 │              "column": {
182 │                "index": 0,
183 │                "name": "id"
184 │              }
185 │            }
186 │          ],
187 │          "destination_vertex_mappings": [
188 │            {
189 │              "column": {
190 │                "index": 1,
191 │                "name": "id"
192 │              }
193 │            }
194 │          ]
195 │        },
196 │        {
197 │          "type_triplet": {
198 │            "edge": "CONTAINEROF",
199 │            "source_vertex": "FORUM",
200 │            "destination_vertex": "POST"
```

```
201          },
202          "inputs": [
203            "dynamic/forum_containerOf_post_0_0.csv"
204          ],
205          "source_vertex_mappings": [
206            {
207              "column": {
208                "index": 0,
209                "name": "id"
210              }
211            }
212          ],
213          "destination_vertex_mappings": [
214            {
215              "column": {
216                "index": 1,
217                "name": "id"
218              }
219            }
220          ]
221        },
222        {
223          "type_triplet": {
224            "edge": "HASMEMBER",
225            "source_vertex": "FORUM",
226            "destination_vertex": "PERSON"
227          },
228          "inputs": [
229            "dynamic/forum_hasMember_person_0_0.csv"
230          ],
231          "source_vertex_mappings": [
232            {
233              "column": {
234                "index": 0,
235                "name": "id"
236              }
237            }
238          ],
239          "destination_vertex_mappings": [
240            {
241              "column": {
242                "index": 1,
243                "name": "id"
244              }
245            }
246          ]
247        },
248        {
249          "type_triplet": {
250            "edge": "HASMODERATOR",
251            "source_vertex": "FORUM",
252            "destination_vertex": "PERSON"
253          },
254          "inputs": [
255            "dynamic/forum_hasModerator_person_0_0.csv"
256          ],
257          "source_vertex_mappings": [
258            {
```

```
259        "column": {
260          "index": 0,
261          "name": "id"
262        }
263      }
264    ],
265    "destination_vertex_mappings": [
266      {
267        "column": {
268          "index": 1,
269          "name": "id"
270        }
271      }
272    ]
273  },
274  {
275    "type_triplet": {
276      "edge": "HASINTEREST",
277      "source_vertex": "PERSON",
278      "destination_vertex": "TAG"
279    },
280    "inputs": [
281      "dynamic/person_hasInterest_tag_0_0.csv"
282    ],
283    "source_vertex_mappings": [
284      {
285        "column": {
286          "index": 0,
287          "name": "id"
288        }
289      }
290    ],
291    "destination_vertex_mappings": [
292      {
293        "column": {
294          "index": 1,
295          "name": "id"
296        }
297      }
298    ]
299  },
300  {
301    "type_triplet": {
302      "edge": "ISLOCATEDIN",
303      "source_vertex": "COMMENT",
304      "destination_vertex": "PLACE"
305    },
306    "inputs": [
307      "dynamic/comment_isLocatedIn_place_0_0.csv"
308    ],
309    "source_vertex_mappings": [
310      {
311        "column": {
312          "index": 0,
313          "name": "id"
314        }
315      }
316    ],
```

```
317    "destination_vertex_mappings": [
318      {
319        "column": {
320          "index": 1,
321          "name": "id"
322        }
323      }
324    ]
325  },
326  {
327    "type_triplet": {
328      "edge": "ISLOCATEDIN",
329      "source_vertex": "PERSON",
330      "destination_vertex": "PLACE"
331    },
332    "inputs": [
333      "dynamic/person_isLocatedIn_place_0_0.csv"
334    ],
335    "source_vertex_mappings": [
336      {
337        "column": {
338          "index": 0,
339          "name": "id"
340        }
341      }
342    ],
343    "destination_vertex_mappings": [
344      {
345        "column": {
346          "index": 1,
347          "name": "id"
348        }
349      }
350    ]
351  },
352  {
353    "type_triplet": {
354      "edge": "ISLOCATEDIN",
355      "source_vertex": "POST",
356      "destination_vertex": "PLACE"
357    },
358    "inputs": [
359      "dynamic/post_isLocatedIn_place_0_0.csv"
360    ],
361    "source_vertex_mappings": [
362      {
363        "column": {
364          "index": 0,
365          "name": "id"
366        }
367      }
368    ],
369    "destination_vertex_mappings": [
370      {
371        "column": {
372          "index": 1,
373          "name": "id"
374        }
```

```
375            }
376          ]
377        },
378        {
379          "type_triplet": {
380            "edge": "ISLOCATEDIN",
381            "source_vertex": "ORGANISATION",
382            "destination_vertex": "PLACE"
383          },
384          "inputs": [
385            "static/organisation_isLocatedIn_place_0_0.csv"
386          ],
387          "source_vertex_mappings": [
388            {
389              "column": {
390                "index": 0,
391                "name": "id"
392              }
393            }
394          ],
395          "destination_vertex_mappings": [
396            {
397              "column": {
398                "index": 1,
399                "name": "id"
400              }
401            }
402          ]
403        },
404        {
405          "type_triplet": {
406            "edge": "KNOWS",
407            "source_vertex": "PERSON",
408            "destination_vertex": "PERSON"
409          },
410          "inputs": [
411            "dynamic/person_knows_person_0_0.csv"
412          ],
413          "source_vertex_mappings": [
414            {
415              "column": {
416                "index": 0,
417                "name": "id"
418              }
419            }
420          ],
421          "destination_vertex_mappings": [
422            {
423              "column": {
424                "index": 1,
425                "name": "id"
426              }
427            }
428          ]
429        },
430        {
431          "type_triplet": {
432            "edge": "LIKES",
```

```
433        "source_vertex": "PERSON",
434        "destination_vertex": "COMMENT"
435      },
436      "inputs": [
437        "dynamic/person_likes_comment_0_0.csv"
438      ],
439      "source_vertex_mappings": [
440        {
441          "column": {
442            "index": 0,
443            "name": "id"
444          }
445        }
446      ],
447      "destination_vertex_mappings": [
448        {
449          "column": {
450            "index": 1,
451            "name": "id"
452          }
453        }
454      ],
455      "column_mappings": [
456        {
457          "column": {
458            "index": 2,
459            "name": "creationDate"
460          },
461          "property": "creationDate"
462        }
463      ]
464    },
465    {
466      "type_triplet": {
467        "edge": "LIKES",
468        "source_vertex": "PERSON",
469        "destination_vertex": "POST"
470      },
471      "inputs": [
472        "dynamic/person_likes_post_0_0.csv"
473      ],
474      "source_vertex_mappings": [
475        {
476          "column": {
477            "index": 0,
478            "name": "id"
479          }
480        }
481      ],
482      "destination_vertex_mappings": [
483        {
484          "column": {
485            "index": 1,
486            "name": "id"
487          }
488        }
489      ],
490      "column_mappings": [
```

```
491         {
492           "column": {
493             "index": 2,
494             "name": "creationDate"
495           },
496           "property": "creationDate"
497         }
498       ]
499     },
500     {
501       "type_triplet": {
502         "edge": "WORKAT",
503         "source_vertex": "PERSON",
504         "destination_vertex": "ORGANISATION"
505       },
506       "inputs": [
507         "dynamic/person_workAt_organisation_0_0.csv"
508       ],
509       "source_vertex_mappings": [
510         {
511           "column": {
512             "index": 0,
513             "name": "id"
514           }
515         }
516       ],
517       "destination_vertex_mappings": [
518         {
519           "column": {
520             "index": 1,
521             "name": "id"
522           }
523         }
524       ],
525       "column_mappings": [
526         {
527           "column": {
528             "index": 2,
529             "name": "workFrom"
530           },
531           "property": "workFrom"
532         }
533       ]
534     },
535     {
536       "type_triplet": {
537         "edge": "ISPARTOF",
538         "source_vertex": "PLACE",
539         "destination_vertex": "PLACE"
540       },
541       "inputs": [
542         "static/place_isPartOf_place_0_0.csv"
543       ],
544       "source_vertex_mappings": [
545         {
546           "column": {
547             "index": 0,
548             "name": "id"
```

```
549              }
550            }
551          ],
552          "destination_vertex_mappings": [
553            {
554              "column": {
555                "index": 1,
556                "name": "id"
557              }
558            }
559          ]
560        },
561        {
562          "type_triplet": {
563            "edge": "HASTYPE",
564            "source_vertex": "TAG",
565            "destination_vertex": "TAGCLASS"
566          },
567          "inputs": [
568            "static/tag_hasType_tagclass_0_0.csv"
569          ],
570          "source_vertex_mappings": [
571            {
572              "column": {
573                "index": 0,
574                "name": "id"
575              }
576            }
577          ],
578          "destination_vertex_mappings": [
579            {
580              "column": {
581                "index": 1,
582                "name": "id"
583              }
584            }
585          ]
586        },
587        {
588          "type_triplet": {
589            "edge": "ISSUBCLASSOF",
590            "source_vertex": "TAGCLASS",
591            "destination_vertex": "TAGCLASS"
592          },
593          "inputs": [
594            "static/tagclass_isSubclassOf_tagclass_0_0.csv"
595          ],
596          "source_vertex_mappings": [
597            {
598              "column": {
599                "index": 0,
600                "name": "id"
601              }
602            }
603          ],
604          "destination_vertex_mappings": [
605            {
606              "column": {
```

```
607          "index": 1,
608          "name": "id"
609        }
610      }
611    ]
612  },
613  {
614    "type_triplet": {
615      "edge": "STUDYAT",
616      "source_vertex": "PERSON",
617      "destination_vertex": "ORGANISATION"
618    },
619    "inputs": [
620      "dynamic/person_studyAt_organisation_0_0.csv"
621    ],
622    "source_vertex_mappings": [
623      {
624        "column": {
625          "index": 0,
626          "name": "id"
627        }
628      }
629    ],
630    "destination_vertex_mappings": [
631      {
632        "column": {
633          "index": 1,
634          "name": "id"
635        }
636      }
637    ],
638    "column_mappings": [
639      {
640        "column": {
641          "index": 2,
642          "name": "classYear"
643        },
644        "property": "classYear"
645      }
646    ]
647  }
648  ]
649 }
```

Listing A.9: Content of `schema.json` describing the data schema

```
1  {
2    "schema": {
3      "vertex_types": [
4        {
5          "type_id": 0,
6          "type_name": "PLACE",
7          "properties": [
8            {
9              "property_id": 0,
10             "property_name": "id",
11             "property_type": {
12               "primitive_type": "INT64"
```

```
13              }
14            },
15            {
16              "property_id": 1,
17              "property_name": "name",
18              "property_type": {
19                "varchar": {
20                  "max_length": 256
21                }
22              }
23            },
24            {
25              "property_id": 2,
26              "property_name": "url",
27              "property_type": {
28                "varchar": {
29                  "max_length": 256
30                }
31              }
32            },
33            {
34              "property_id": 3,
35              "property_name": "type",
36              "property_type": {
37                "varchar": {
38                  "max_length": 64
39                }
40              }
41            }
42          ],
43          "primary_keys": [
44            "id"
45          ]
46        },
47        {
48          "type_id": 1,
49          "type_name": "PERSON",
50          "properties": [
51            {
52              "property_id": 0,
53              "property_name": "id",
54              "property_type": {
55                "primitive_type": "INT64"
56              }
57            },
58            {
59              "property_id": 1,
60              "property_name": "firstName",
61              "property_type": {
62                "varchar": {
63                  "max_length": 40
64                }
65              }
66            },
67            {
68              "property_id": 2,
69              "property_name": "lastName",
70              "property_type": {
```

```
 71            "varchar": {
 72              "max_length": 40
 73            }
 74          }
 75        },
 76        {
 77          "property_id": 3,
 78          "property_name": "gender",
 79          "property_type": {
 80            "varchar": {
 81              "max_length": 40
 82            }
 83          }
 84        },
 85        {
 86          "property_id": 4,
 87          "property_name": "birthday",
 88          "property_type": {
 89            "date": "date"
 90          }
 91        },
 92        {
 93          "property_id": 5,
 94          "property_name": "creationDate",
 95          "property_type": {
 96            "date": "date"
 97          }
 98        },
 99        {
100          "property_id": 6,
101          "property_name": "locationIP",
102          "property_type": {
103            "varchar": {
104              "max_length": 40
105            }
106          }
107        },
108        {
109          "property_id": 7,
110          "property_name": "browserUsed",
111          "property_type": {
112            "varchar": {
113              "max_length": 40
114            }
115          }
116        },
117        {
118          "property_id": 8,
119          "property_name": "language",
120          "property_type": {
121            "varchar": {
122              "max_length": 2048
123            }
124          }
125        },
126        {
127          "property_id": 9,
128          "property_name": "email",
```

```
129            "property_type": {
130              "varchar": {
131                "max_length": 2048
132              }
133            }
134          }
135        ],
136        "primary_keys": [
137          "id"
138        ]
139      },
140      {
141        "type_id": 2,
142        "type_name": "COMMENT",
143        "properties": [
144          {
145            "property_id": 0,
146            "property_name": "id",
147            "property_type": {
148              "primitive_type": "INT64"
149            }
150          },
151          {
152            "property_id": 1,
153            "property_name": "creationDate",
154            "property_type": {
155              "date": "date"
156            }
157          },
158          {
159            "property_id": 2,
160            "property_name": "locationIP",
161            "property_type": {
162              "varchar": {
163                "max_length": 40
164              }
165            }
166          },
167          {
168            "property_id": 3,
169            "property_name": "browserUsed",
170            "property_type": {
171              "varchar": {
172                "max_length": 40
173              }
174            }
175          },
176          {
177            "property_id": 4,
178            "property_name": "content",
179            "property_type": {
180              "varchar": {
181                "max_length": 2000
182              }
183            }
184          },
185          {
186            "property_id": 5,
```

```
187          "property_name": "length",
188          "property_type": {
189            "primitive_type": "INT32"
190          }
191        }
192      ],
193      "primary_keys": [
194        "id"
195      ]
196    },
197    {
198      "type_id": 3,
199      "type_name": "POST",
200      "properties": [
201        {
202          "property_id": 0,
203          "property_name": "id",
204          "property_type": {
205            "primitive_type": "INT64"
206          }
207        },
208        {
209          "property_id": 1,
210          "property_name": "imageFile",
211          "property_type": {
212            "varchar": {
213              "max_length": 40
214            }
215          }
216        },
217        {
218          "property_id": 2,
219          "property_name": "creationDate",
220          "property_type": {
221            "date": "date"
222          }
223        },
224        {
225          "property_id": 3,
226          "property_name": "locationIP",
227          "property_type": {
228            "varchar": {
229              "max_length": 40
230            }
231          }
232        },
233        {
234          "property_id": 4,
235          "property_name": "browserUsed",
236          "property_type": {
237            "varchar": {
238              "max_length": 40
239            }
240          }
241        },
242        {
243          "property_id": 5,
244          "property_name": "language",
```

```
245        "property_type": {
246          "varchar": {
247            "max_length": 40
248          }
249        }
250      },
251      {
252        "property_id": 6,
253        "property_name": "content",
254        "property_type": {
255          "varchar": {
256            "max_length": 2000
257          }
258        }
259      },
260      {
261        "property_id": 7,
262        "property_name": "length",
263        "property_type": {
264          "primitive_type": "INT32"
265        }
266      }
267    ],
268    "primary_keys": [
269      "id"
270    ]
271  },
272  {
273    "type_id": 4,
274    "type_name": "FORUM",
275    "properties": [
276      {
277        "property_id": 0,
278        "property_name": "id",
279        "property_type": {
280          "primitive_type": "INT64"
281        }
282      },
283      {
284        "property_id": 1,
285        "property_name": "title",
286        "property_type": {
287          "varchar": {
288            "max_length": 256
289          }
290        }
291      },
292      {
293        "property_id": 2,
294        "property_name": "creationDate",
295        "property_type": {
296          "date": "date"
297        }
298      }
299    ],
300    "primary_keys": [
301      "id"
302    ]
```

```
303        },
304        {
305          "type_id": 5,
306          "type_name": "ORGANISATION",
307          "properties": [
308            {
309              "property_id": 0,
310              "property_name": "id",
311              "property_type": {
312                "primitive_type": "INT64"
313              }
314            },
315            {
316              "property_id": 1,
317              "property_name": "type",
318              "property_type": {
319                "varchar": {
320                  "max_length": 64
321                }
322              }
323            },
324            {
325              "property_id": 2,
326              "property_name": "name",
327              "property_type": {
328                "varchar": {
329                  "max_length": 256
330                }
331              }
332            },
333            {
334              "property_id": 3,
335              "property_name": "url",
336              "property_type": {
337                "varchar": {
338                  "max_length": 256
339                }
340              }
341            }
342          ],
343          "primary_keys": [
344            "id"
345          ]
346        },
347        {
348          "type_id": 6,
349          "type_name": "TAGCLASS",
350          "properties": [
351            {
352              "property_id": 0,
353              "property_name": "id",
354              "property_type": {
355                "primitive_type": "INT64"
356              }
357            },
358            {
359              "property_id": 1,
360              "property_name": "name",
```

```
361            "property_type": {
362              "varchar": {
363                "max_length": 256
364              }
365            }
366          },
367          {
368            "property_id": 2,
369            "property_name": "url",
370            "property_type": {
371              "varchar": {
372                "max_length": 256
373              }
374            }
375          }
376        ],
377        "primary_keys": [
378          "id"
379        ]
380      },
381      {
382        "type_id": 7,
383        "type_name": "TAG",
384        "properties": [
385          {
386            "property_id": 0,
387            "property_name": "id",
388            "property_type": {
389              "primitive_type": "INT64"
390            }
391          },
392          {
393            "property_id": 1,
394            "property_name": "name",
395            "property_type": {
396              "varchar": {
397                "max_length": 256
398              }
399            }
400          },
401          {
402            "property_id": 2,
403            "property_name": "url",
404            "property_type": {
405              "varchar": {
406                "max_length": 256
407              }
408            }
409          }
410        ],
411        "primary_keys": [
412          "id"
413        ]
414      }
415    ],
416    "edge_types": [
417      {
418        "type_id": 0,
```

```
419        "type_name": "HASCREATOR",
420        "vertex_type_pair_relations": [
421          {
422            "source_vertex": "COMMENT",
423            "destination_vertex": "PERSON",
424            "relation": "MANY_TO_ONE",
425            "x_csr_params": {
426              "sort_on_compaction": true
427            }
428          },
429          {
430            "source_vertex": "POST",
431            "destination_vertex": "PERSON",
432            "relation": "MANY_TO_ONE",
433            "x_csr_params": {
434              "sort_on_compaction": true
435            }
436          }
437        ]
438      },
439      {
440        "type_id": 1,
441        "type_name": "HASTAG",
442        "vertex_type_pair_relations": [
443          {
444            "source_vertex": "POST",
445            "destination_vertex": "TAG",
446            "relation": "MANY_TO_MANY"
447          },
448          {
449            "source_vertex": "FORUM",
450            "destination_vertex": "TAG",
451            "relation": "MANY_TO_MANY"
452          },
453          {
454            "source_vertex": "COMMENT",
455            "destination_vertex": "TAG",
456            "relation": "MANY_TO_MANY"
457          }
458        ]
459      },
460      {
461        "type_id": 2,
462        "type_name": "REPLYOF",
463        "vertex_type_pair_relations": [
464          {
465            "source_vertex": "COMMENT",
466            "destination_vertex": "COMMENT",
467            "relation": "MANY_TO_ONE",
468            "x_csr_params": null
469          },
470          {
471            "source_vertex": "COMMENT",
472            "destination_vertex": "POST",
473            "relation": "MANY_TO_ONE",
474            "x_csr_params": null
475          }
476        ]
```

```
477        },
478        {
479          "type_id": 3,
480          "type_name": "CONTAINEROF",
481          "vertex_type_pair_relations": [
482            {
483              "source_vertex": "FORUM",
484              "destination_vertex": "POST",
485              "relation": "ONE_TO_MANY",
486              "x_csr_params": {
487                "edge_storage_strategy": "ONLY_IN"
488              }
489            }
490          ]
491        },
492        {
493          "type_id": 4,
494          "type_name": "HASMEMBER",
495          "vertex_type_pair_relations": [
496            {
497              "source_vertex": "FORUM",
498              "destination_vertex": "PERSON",
499              "relation": "MANY_TO_MANY"
500            }
501          ],
502          "properties": [
503            {
504              "property_id": 0,
505              "property_name": "joinDate",
506              "property_type": {
507                "date": "date"
508              }
509            }
510          ]
511        },
512        {
513          "type_id": 5,
514          "type_name": "HASMODERATOR",
515          "vertex_type_pair_relations": [
516            {
517              "source_vertex": "FORUM",
518              "destination_vertex": "PERSON",
519              "relation": "MANY_TO_ONE",
520              "x_csr_params": {
521                "edge_storage_strategy": "ONLY_OUT"
522              }
523            }
524          ]
525        },
526        {
527          "type_id": 6,
528          "type_name": "HASINTEREST",
529          "vertex_type_pair_relations": [
530            {
531              "source_vertex": "PERSON",
532              "destination_vertex": "TAG",
533              "relation": "MANY_TO_MANY",
534              "x_csr_params": {
```

```
535              "edge_storage_strategy": "ONLY_OUT"
536            }
537          }
538        ]
539      },
540      {
541        "type_id": 7,
542        "type_name": "ISLOCATEDIN",
543        "vertex_type_pair_relations": [
544          {
545            "source_vertex": "COMMENT",
546            "destination_vertex": "PLACE",
547            "relation": "MANY_TO_ONE",
548            "x_csr_params": null
549          },
550          {
551            "source_vertex": "PERSON",
552            "destination_vertex": "PLACE",
553            "relation": "MANY_TO_ONE",
554            "x_csr_params": null
555          },
556          {
557            "source_vertex": "POST",
558            "destination_vertex": "PLACE",
559            "relation": "MANY_TO_ONE",
560            "x_csr_params": null
561          },
562          {
563            "source_vertex": "ORGANISATION",
564            "destination_vertex": "PLACE",
565            "relation": "MANY_TO_ONE",
566            "x_csr_params": null
567          }
568        ]
569      },
570      {
571        "type_id": 8,
572        "type_name": "KNOWS",
573        "vertex_type_pair_relations": [
574          {
575            "source_vertex": "PERSON",
576            "destination_vertex": "PERSON",
577            "relation": "MANY_TO_MANY"
578          }
579        ],
580        "properties": [
581          {
582            "property_id": 0,
583            "property_name": "creationDate",
584            "property_type": {
585              "date": "date"
586            }
587          }
588        ]
589      },
590      {
591        "type_id": 9,
592        "type_name": "LIKES",
```

```
593      "vertex_type_pair_relations": [
594        {
595          "source_vertex": "PERSON",
596          "destination_vertex": "COMMENT",
597          "relation": "MANY_TO_MANY"
598        },
599        {
600          "source_vertex": "PERSON",
601          "destination_vertex": "POST",
602          "relation": "MANY_TO_MANY"
603        }
604      ],
605      "properties": [
606        {
607          "property_id": 0,
608          "property_name": "creationDate",
609          "property_type": {
610            "date": "date"
611          }
612        }
613      ]
614    },
615    {
616      "type_id": 10,
617      "type_name": "WORKAT",
618      "vertex_type_pair_relations": [
619        {
620          "source_vertex": "PERSON",
621          "destination_vertex": "ORGANISATION",
622          "relation": "MANY_TO_MANY"
623        }
624      ],
625      "properties": [
626        {
627          "property_id": 0,
628          "property_name": "workFrom",
629          "property_type": {
630            "primitive_type": "INT32"
631          }
632        }
633      ]
634    },
635    {
636      "type_id": 11,
637      "type_name": "ISPARTOF",
638      "vertex_type_pair_relations": [
639        {
640          "source_vertex": "PLACE",
641          "destination_vertex": "PLACE",
642          "relation": "MANY_TO_ONE",
643          "x_csr_params": null
644        }
645      ]
646    },
647    {
648      "type_id": 12,
649      "type_name": "HASTYPE",
650      "vertex_type_pair_relations": [
```

```
651            {
652              "source_vertex": "TAG",
653              "destination_vertex": "TAGCLASS",
654              "relation": "MANY_TO_ONE",
655              "x_csr_params": null
656            }
657          ]
658        },
659        {
660          "type_id": 13,
661          "type_name": "ISSUBCLASSOF",
662          "vertex_type_pair_relations": [
663            {
664              "source_vertex": "TAGCLASS",
665              "destination_vertex": "TAGCLASS",
666              "relation": "MANY_TO_ONE",
667              "x_csr_params": null
668            }
669          ]
670        },
671        {
672          "type_id": 14,
673          "type_name": "STUDYAT",
674          "vertex_type_pair_relations": [
675            {
676              "source_vertex": "PERSON",
677              "destination_vertex": "ORGANISATION",
678              "relation": "MANY_TO_MANY",
679              "x_csr_params": {
680                "edge_storage_strategy": "ONLY_OUT"
681              }
682            }
683          ],
684          "properties": [
685            {
686              "property_id": 0,
687              "property_name": "classYear",
688              "property_type": {
689                "primitive_type": "INT32"
690              }
691            }
692          ]
693        }
694      ]
695    }
696 }
```

A.6   Benchmark configuration

Listing A.10: Contents of `interactive-benchmark-sf30.properties` used for scale factor 30

```
 1  #for ldbc test, endpoint is the cypher address
 2  endpoint=server_ip:9090
 3  version=v1.0
 4  projectId=ldbc-benchmark
 5  graphName=testgraph
 6  queryDir=queries
 7  resource=cypher-planner
 8
 9  #ges
10  printQueryNames=false
11  printQueryStrings=false
12  printQueryResults=false
13
14  status=1
15  thread_count=128
16  name=LDBC-SNB
17  mode=execute_benchmark
18  results_log=true
19  time_unit=MICROSECONDS
20  time_compression_ratio=0.001
21  peer_identifiers=
22  workload_statistics=true
23  spinner_wait_duration=1
24  help=false
25  ignore_scheduled_start_times=false
26
27  workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
28  db=org.ldbcouncil.snb.impls.workloads.ges.interactive.GesInteractiveDb
29
30  skip=0
31  warmup=68731688
32  operation_count=274974712
33
34  ldbc.snb.interactive.updates_dir=
35  ldbc.snb.interactive.parameters_dir=
36  ldbc.snb.interactive.short_read_dissipation=0.2
37
38  # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
39  ldbc.snb.interactive.scale_factor=30
40
41  # *** For debugging purposes ***
42
43  ldbc.snb.interactive.LdbcQuery1_enable=true
44  ldbc.snb.interactive.LdbcQuery2_enable=true
45  ldbc.snb.interactive.LdbcQuery3_enable=true
46  ldbc.snb.interactive.LdbcQuery4_enable=true
47  ldbc.snb.interactive.LdbcQuery5_enable=true
48  ldbc.snb.interactive.LdbcQuery6_enable=true
49  ldbc.snb.interactive.LdbcQuery7_enable=true
50  ldbc.snb.interactive.LdbcQuery8_enable=true
51  ldbc.snb.interactive.LdbcQuery9_enable=true
52  ldbc.snb.interactive.LdbcQuery10_enable=true
53  ldbc.snb.interactive.LdbcQuery11_enable=true
54  ldbc.snb.interactive.LdbcQuery12_enable=true
```

```
55  ldbc.snb.interactive.LdbcQuery13_enable=true
56  ldbc.snb.interactive.LdbcQuery14_enable=true
57
58  ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
59  ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
60  ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
61  ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
62  ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
63  ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
64  ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
65
66  ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
67  ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
68  ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
69  ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
70  ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
71  ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
72  ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
73  ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```

Listing A.11: Contents of `interactive-benchmark-sf100.properties` used for scale factor 100

```
1   #for ldbc test, endpoint is the cypher address
2   endpoint=10.0.0.232:9090
3   version=v1.0
4   projectId=ldbc-benchmark
5   graphName=testgraph
6   queryDir=queries
7   resource=cypher-planner
8
9   #ges
10  printQueryNames=false
11  printQueryStrings=false
12  printQueryResults=false
13
14  status=1
15  thread_count=128
16  name=LDBC-SNB
17  mode=execute_benchmark
18  results_log=true
19  time_unit=MICROSECONDS
20  time_compression_ratio=0.0029
21  peer_identifiers=
22  workload_statistics=true
23  spinner_wait_duration=1
24  help=false
25  ignore_scheduled_start_times=false
26
27  workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
28  db=org.ldbcouncil.snb.impls.workloads.ges.interactive.GesInteractiveDb
29
30  skip=0
31  warmup=86410706
32  operation_count=345651752
33
34  ldbc.snb.interactive.updates_dir=/disk/data/SF100/social_network
35  ldbc.snb.interactive.parameters_dir=/disk/data/SF100/substitution_parameters
36  ldbc.snb.interactive.short_read_dissipation=0.2
```

```
37
38 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
39 ldbc.snb.interactive.scale_factor=100
40
41 # *** For debugging purposes ***
42
43 ldbc.snb.interactive.LdbcQuery1_enable=true
44 ldbc.snb.interactive.LdbcQuery2_enable=true
45 ldbc.snb.interactive.LdbcQuery3_enable=true
46 ldbc.snb.interactive.LdbcQuery4_enable=true
47 ldbc.snb.interactive.LdbcQuery5_enable=true
48 ldbc.snb.interactive.LdbcQuery6_enable=true
49 ldbc.snb.interactive.LdbcQuery7_enable=true
50 ldbc.snb.interactive.LdbcQuery8_enable=true
51 ldbc.snb.interactive.LdbcQuery9_enable=true
52 ldbc.snb.interactive.LdbcQuery10_enable=true
53 ldbc.snb.interactive.LdbcQuery11_enable=true
54 ldbc.snb.interactive.LdbcQuery12_enable=true
55 ldbc.snb.interactive.LdbcQuery13_enable=true
56 ldbc.snb.interactive.LdbcQuery14_enable=true
57
58 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
59 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
60 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
61 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
62 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
63 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
64 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
65
66 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
67 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
68 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
69 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
70 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
71 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
72 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
73 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```

Listing A.12: Contents of `interactive-benchmark-sf300.properties` used for scale factor 300

```
1 #for ldbc test, endpoint is the cypher address
2 endpoint=server_ip:9090
3 version=v1.0
4 projectId=ldbc-benchmark
5 graphName=testgraph
6 queryDir=queries
7 resource=cypher-planner
8
9 #ges
10 printQueryNames=false
11 printQueryStrings=false
12 printQueryResults=false
13
14 status=1
15 thread_count=128
16 name=LDBC-SNB
17 mode=execute_benchmark
18 results_log=true
```

```
19  time_unit=MICROSECONDS
20  time_compression_ratio=0.0114
21  peer_identifiers=
22  workload_statistics=true
23  spinner_wait_duration=1
24  help=false
25  ignore_scheduled_start_times=false
26
27  workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
28  db=org.ldbcouncil.snb.impls.workloads.ges.interactive.GesInteractiveDb
29
30  skip=0
31  warmup=74997439
32  operation_count=299979699
33
34  ldbc.snb.interactive.updates_dir=
35  ldbc.snb.interactive.parameters_dir=
36  ldbc.snb.interactive.short_read_dissipation=0.2
37
38  # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
39  ldbc.snb.interactive.scale_factor=300
40
41  # *** For debugging purposes ***
42
43  ldbc.snb.interactive.LdbcQuery1_enable=true
44  ldbc.snb.interactive.LdbcQuery2_enable=true
45  ldbc.snb.interactive.LdbcQuery3_enable=true
46  ldbc.snb.interactive.LdbcQuery4_enable=true
47  ldbc.snb.interactive.LdbcQuery5_enable=true
48  ldbc.snb.interactive.LdbcQuery6_enable=true
49  ldbc.snb.interactive.LdbcQuery7_enable=true
50  ldbc.snb.interactive.LdbcQuery8_enable=true
51  ldbc.snb.interactive.LdbcQuery9_enable=true
52  ldbc.snb.interactive.LdbcQuery10_enable=true
53  ldbc.snb.interactive.LdbcQuery11_enable=true
54  ldbc.snb.interactive.LdbcQuery12_enable=true
55  ldbc.snb.interactive.LdbcQuery13_enable=true
56  ldbc.snb.interactive.LdbcQuery14_enable=true
57
58  ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
59  ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
60  ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
61  ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
62  ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
63  ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
64  ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
65
66  ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
67  ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
68  ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
69  ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
70  ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
71  ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
72  ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
73  ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```

A.7   Validation configuration

Listing A.13: The contents of `interactive-validate.properties`

```
 1  endpoint=server_ip:9090
 2  version=v1.0
 3  projectId=ldbc-benchmark
 4  graphName=testgraph
 5  queryDir=queries/
 6  resource=cypher-planner
 7
 8  printQueryNames=false
 9  printQueryStrings=false
10  printQueryResults=false
11
12  status=1
13  thread_count=1
14  mode=validate_database
15  name=LDBC-SNB
16  results_log=false
17  time_unit=MILLISECONDS
18  time_compression_ratio=0.05
19  peer_identifiers=
20  workload_statistics=false
21  spinner_wait_duration=0
22  help=false
23  ignore_scheduled_start_times=true
24
25  workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
26  db=org.ldbcouncil.snb.impls.workloads.ges.interactive.GesInteractiveDb
27
28
29  skip=0
30  operation_count=10000
31  validate_database=
32  ldbc.snb.interactive.parameters_dir=
33  ldbc.snb.interactive.short_read_dissipation=0.2
34  # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
35  ldbc.snb.interactive.scale_factor=10
36
37  ldbc.snb.interactive.LdbcQuery1_freq=1
38  ldbc.snb.interactive.LdbcQuery2_freq=1
39  ldbc.snb.interactive.LdbcQuery3_freq=1
40  ldbc.snb.interactive.LdbcQuery4_freq=1
41  ldbc.snb.interactive.LdbcQuery5_freq=1
42  ldbc.snb.interactive.LdbcQuery6_freq=1
43  ldbc.snb.interactive.LdbcQuery7_freq=1
44  ldbc.snb.interactive.LdbcQuery8_freq=1
45  ldbc.snb.interactive.LdbcQuery9_freq=1
46  ldbc.snb.interactive.LdbcQuery10_freq=1
47  ldbc.snb.interactive.LdbcQuery11_freq=1
48  ldbc.snb.interactive.LdbcQuery12_freq=1
49  ldbc.snb.interactive.LdbcQuery13_freq=1
50  ldbc.snb.interactive.LdbcQuery14_freq=1
51
52  ldbc.snb.interactive.LdbcQuery1_enable=true
53  ldbc.snb.interactive.LdbcQuery2_enable=true
54  ldbc.snb.interactive.LdbcQuery3_enable=true
```

```
55  ldbc.snb.interactive.LdbcQuery4_enable=true
56  ldbc.snb.interactive.LdbcQuery5_enable=true
57  ldbc.snb.interactive.LdbcQuery6_enable=true
58  ldbc.snb.interactive.LdbcQuery7_enable=true
59  ldbc.snb.interactive.LdbcQuery8_enable=true
60  ldbc.snb.interactive.LdbcQuery9_enable=true
61  ldbc.snb.interactive.LdbcQuery10_enable=true
62  ldbc.snb.interactive.LdbcQuery11_enable=true
63  ldbc.snb.interactive.LdbcQuery12_enable=true
64  ldbc.snb.interactive.LdbcQuery13_enable=true
65  ldbc.snb.interactive.LdbcQuery14_enable=true
66
67  ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
68  ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
69  ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
70  ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
71  ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
72  ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
73  ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
74
75  ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
76  ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
77  ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
78  ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
79  ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
80  ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
81  ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
82  ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```