FinBench: The new LDBC benchmark targeting financial scenario

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(with contributions from members of the FinBench Task Force)
Benchmark Overview
FinBench Motivation

• SNB, Social Network Benchmark, is designed based on social network scenarios, which is limited when applied to the financial service industry.

• FinBench objective is to design a high-quality benchmark for evaluating the performance of graph database systems in financial scenarios, e.g. anti-fraud and risk control, based on financial data patterns and query patterns.
Key Features in FinBench

- Dataset
  - PowerLaw distribution
  - Multiplicity
  - Hub Vertex

- Transaction Workload
  - Read-write query
  - Special graph patterns
  - Time-window filtering
  - Recursive path filtering
  - Truncation
Brief of the initial version

• Standard Design: all key features in proposal implemented
• Workload: Transaction Workload, including 12 complex read queries, 6 simple read queries, 19 write queries and 3 read-write queries
• Dataset: Up to SF10 scale supported
• Implementation on 3 systems: TuGraph, Galaxybase, and UltipaGraph
• Collaboration: 9 vendors in Task Force and 6 developers
Data Design and Generated Datasets

- Data Schema
- Data Distribution
- Datasets Statistics
Data Schema

Person
- id: ID
- name: String
- isBlocked: Boolean
- createTime: DateTime
- gender: String
- birthday: Date
- country: String
- city: String
- apply
- own
- guarantee
- invest
- transfer
- withdraw

Company
- id: ID
- name: String
- isBlocked: Boolean
- createTime: DateTime
- country: String
- city: String
- business: String
- description: String
- url: String
- apply
- own
- guarantee
- invest
- repay
- deposit

Account
- id: ID
- createTime: DateTime
- isBlocked: Boolean
- nickname: String
- phoneNumber: String
- email: Long String
- freqLoginType: String
- lastLoginTime: DateTime
- accountLevel: String
- transfer
- withdraw

Loan
- id: ID
- loanAmount: 64-bit Float
- balance: 64-bit Float
- usage: String
- interestRate: 32-bit Float

Medium
- id: ID
- type: String
- nickname: String
- phoneNumber: String
- email: Long String
- freqLoginType: String
- lastLoginTime: DateTime
- riskLevel: String
- signin
- repay
- deposit

Single edges from src to dst
Multiple edges from src to dst
Data Distribution: Transfer Edge

- Degree: PowerLaw Distribution
- Asymmetric directed graph
- Hub vertex: degree increases with scale
  - MaxDegree = 1000 in SF1
  - MaxDegree = 10000 in SF10
  - Larger scale to be supported

Profiling of SF0.1

- Num of accounts: 26347
- Num of transfer edges: 138209
- Average Degree: 5.245720575397579
- Average Multiplicity: 1.616574068658986
Transaction Workload

- Transaction Workload
- Time Window Filtering
- Recursive Path Filtering
- Read-Write Query
- Truncation
- Query Mix
- Transaction Workload Driver
Transaction Workload

Scenario: financial activities among accounts, persons, companies, loans and media

Queries:

- 12 complex reads: match exact patterns including cycles and trees (see next slide) starting from one or two vertices
- 6 simple reads: discover the neighbourhood of an Account node
- 19 write queries: inserts, updates, deletes (cascade deletion)
- 3 read-write queries: transaction-wrapped complex reads
Transaction Workload: Example Patterns

**Cycle**
[Ref: Transaction Complex Read 4]

**Tree**
[Ref: Transaction Complex Read 6]

**Chain**
[Ref: Transaction Complex Read 11]
Time Window Filtering

- Fact: queries only look back in a limited time window
- Filtering: filter edges between `startTime` and `endTime` in traversal

Blocked medium related accounts
[Ref: Transaction Complex Read 1]
Recursive Path Filtering

Assuming: A -[e1]-> B -[e2]-> ... -> X

- Timestamp order: e1 < ... < ei
- Amount order: e1 > ... > ei

Transfer trace after loan applied
[Ref: Transaction Complex Read 8]
Read-Write Query

- Transaction-wrapped complex reads (risk control strategy)
- If the complex read matches, commit the transaction with write query. Otherwise, transaction abort

Transfer under transfer cycle detection strategy
[Ref: Transaction Read Write 3]
Truncation

- Truncate less-important edges to avoid complexity explosion when traversing
- Truncating is actually sampling
- TruncationLimit and truncationOrder is defined to ensure consistency of results.

For example, keep only the top 100 edges in order of timestamp descending
Benchmark Suite
## Datasets Statistics

| Supported Scale Factor | |V| | |E| |
|------------------------|---|---|---|
| 0.01                    | 8663 | 61674 |
| 0.1                    | 64485 | 610658 |
| 0.3                    | 192971 | 1830891 |
| 1                      | 643241 | 6091820 |
| 3                      | 1928439 | 18243343 |
| 10                     | 6069955 | 51889416 |

FinBench datasets of SF0.01 to SF10 are published at the [Google Drive](https://drive.google.com). These datasets were all generated using csv serializers in the initial version.

*Note: please see the tables in Appendix A for detailed statistics*
Transaction Workload Driver

Inherited from SNB Interactive driver, the driver has 3 modes of operation, all starting with a database containing the initial data set.

1. Generate validation data set
   - single-threaded, sequential execution
   - output: validation results

2. Validate implementation
   - single-threaded, sequential execution
   - input: validation results
   - output:
     - passed/failed validation
     - if failed: expected vs. actual results

3. Execute benchmark
   - multi-threaded, concurrent execution
   - Use TCR to control the load scale
   - output:
     - passed/failed schedule audit
     - throughput (operations per second)
     - per-query performance results
Roadmap and acknowledgement
# Roadmap

<table>
<thead>
<tr>
<th>Version</th>
<th>Estimated Time</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1.0</td>
<td>Mid of 2023</td>
<td>• Runnable and auditable</td>
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</table>
| 0.2.0   | End of 2023    | • Larger scale data generation  
|         |                | • Optimize parameter curation  
|         |                | • Query mix profiling and design |
| 0.3.0   | 2024           | • New workload: Analytics workload |
# Acknowledgement

## Task Force Members

<table>
<thead>
<tr>
<th>Name</th>
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<td>StarGraph</td>
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## Developers
Resources

• Specification: [https://github.com/ldbc/ldbc_finbench_docs](https://github.com/ldbc/ldbc_finbench_docs)

• Benchmark Suite
  • [https://github.com/ldbc/ldbc_finbench_driver](https://github.com/ldbc/ldbc_finbench_driver)
  • [https://github.com/ldbc/ldbc_finbench_datagen](https://github.com/ldbc/ldbc_finbench_datagen)
  • [https://github.com/ldbc/ldbc_finbench_transaction_impls](https://github.com/ldbc/ldbc_finbench_transaction_impls)
  • [https://github.com/ldbc/ldbc_finbench_acid](https://github.com/ldbc/ldbc_finbench_acid)

• Datasets: [https://drive.google.com/drive/folders/1tURBIJE56ZNC9YvMtug31peYD5csizCa?usp=sharing](https://drive.google.com/drive/folders/1tURBIJE56ZNC9YvMtug31peYD5csizCa?usp=sharing)

• Certification audit packages: [https://drive.google.com/drive/folders/1OQXrz2CkQke7SE9KWBiMeEn0KYx-QCOl?usp=sharing](https://drive.google.com/drive/folders/1OQXrz2CkQke7SE9KWBiMeEn0KYx-QCOl?usp=sharing)