DeuceDB: Smarter categorizing and scheduling to amortize background IO costs in LevelDB

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Goal

Decrease background ops overhead to increase user throughput

Dynamically adapt key-value stores to changing workload characteristics in runtime

A recap - DeuceDB_v1 (Project 2)

- TRIAD, the paper we implemented, aims to decrease background work overhead in the presence of a skewed workload (80/20).
- TRIAD, in order to avoid unnecessary background I/O, does hot and cold key separation in the memtable and also delays compaction when there isn’t enough overlap to amortize the cost of the background compaction.
- These efforts help to reduce the overall compute spent in background I/O work and helps improve LevelDB performance.

Evaluations - DeuceDB_v1 (Project 2)

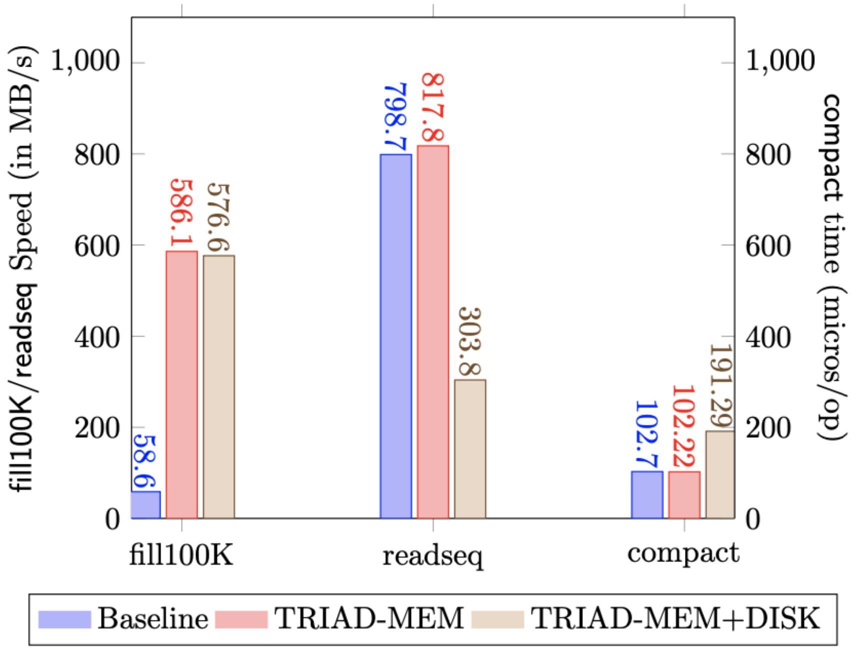


Figure 6: Evaluation on 1 million keys

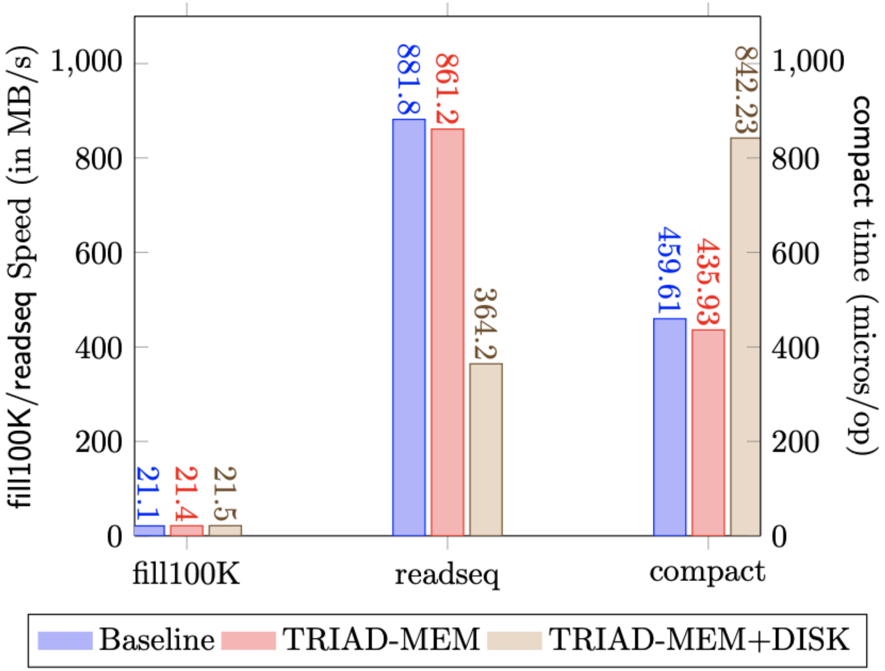


Figure 7: Evaluation on 5 million keys

What’s with the name?

- We implemented **2** algorithms to delay background work when it’s not worth it
- “Deuce” for **2**
- We wanted to sound cooler than we actually are

Problem statement

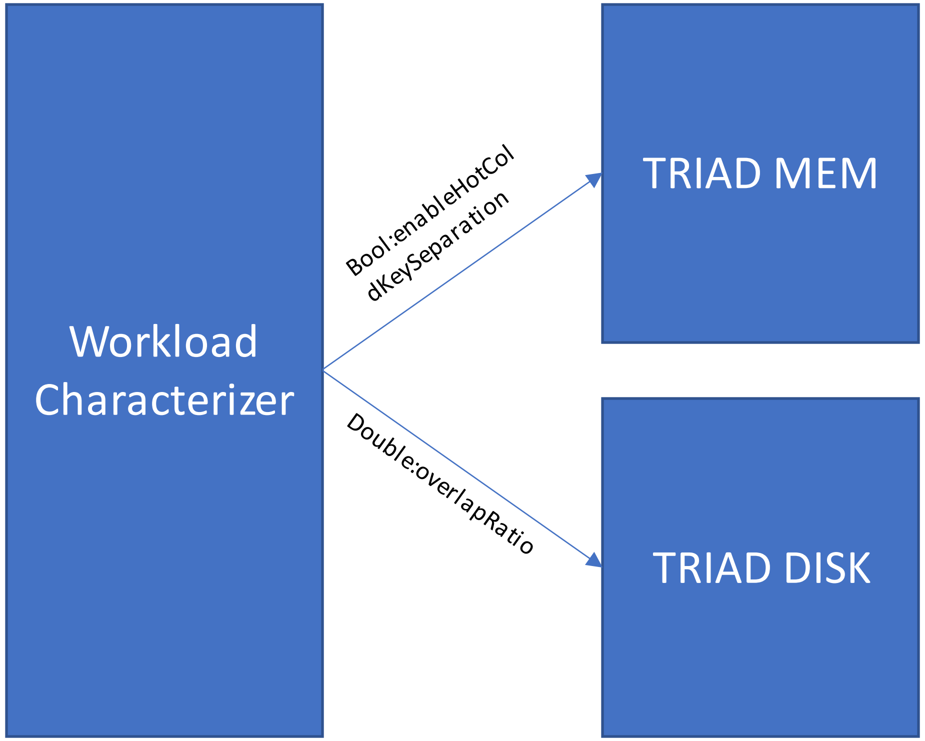
- Databases are usually built keeping in mind a specific type of workload.
- Databases based on LSM are suitable for very fast write throughput
- Databases based on b-tree like structures are built for faster reads.
- Databases, in production could be facing a wide variation of workloads including the worst case for the database in question.

Proposal

- The drawback of TRIAD is that the system is implemented to work well on a skewed workload only.
- In case of uniform workloads, or read only workloads, the performance suffers
- We argue that workload characteristics change over time and databases should be adaptable to the changing workload patterns.
- For this reason, we propose an improvised version of DeuceDB.

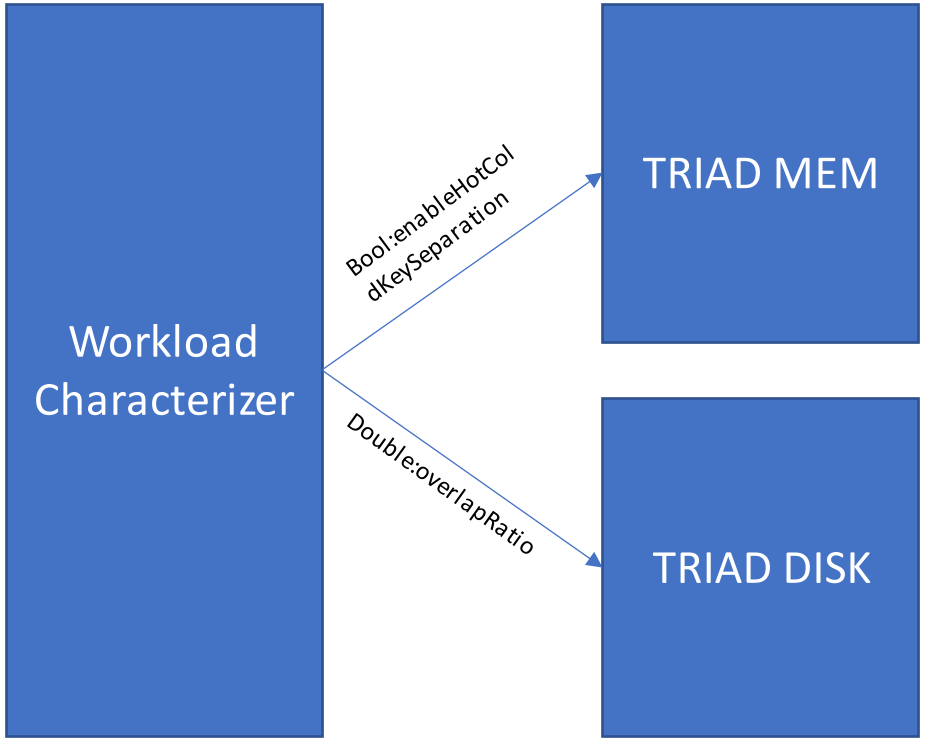
Workload Characterization

- We propose a solution to analyze the current workload condition and characterize it as:
  - Read Heavy
  - Write Heavy
  - Skewed
  - Uniform
- We implement a WorkloadCharacterizer as a new util class to understand the workload characteristic and dynamically adapt parameters of the database at runtime.



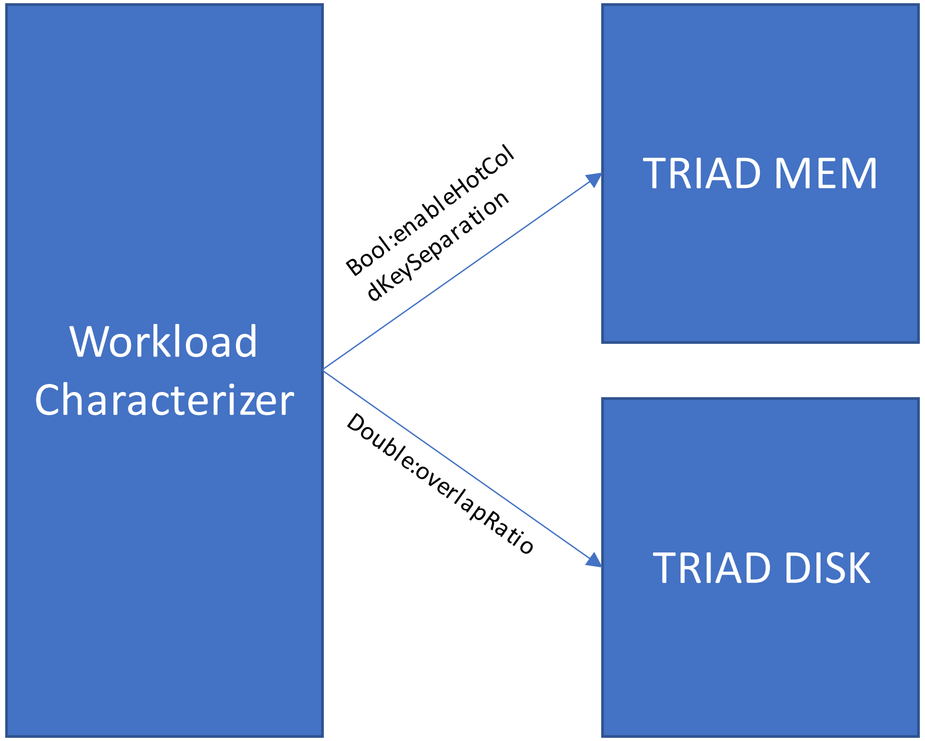
Workload Characterization

- We want to dynamically understand the read to write ratio being experienced by the database.
- For every Put and Get operation, we record the current get count and put count.
- We calculate the ratio in windows of 10k operations to ensure freshness



Workload Characterization

- We use this read to write ratio to modify the overlap ratio which was a hardcoded value in our previous implementation
- If the database is experiencing high reads, we reduce the overlap ratio to make sure we flush data from L0 to L1 faster to make reads faster.
- Else, we increase the overlap ratio threshold to reduce BG work.

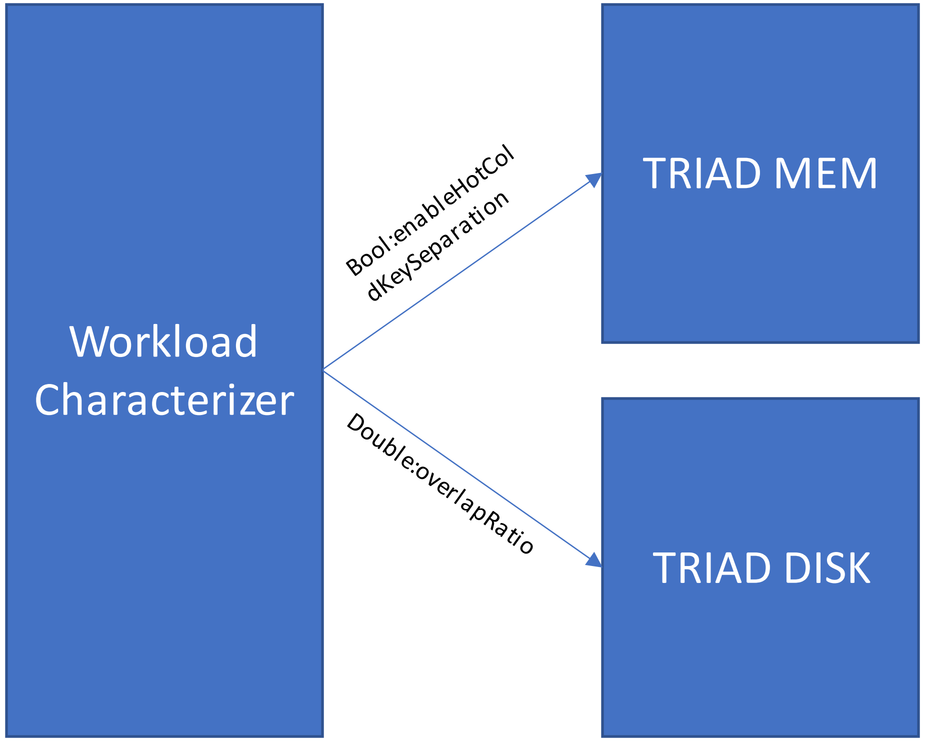


Workload Characterization

- TRIAD MEM improvements
  - For write heavy
    - If skewed

    => enable HotColdKeySeparation
    - If uniform

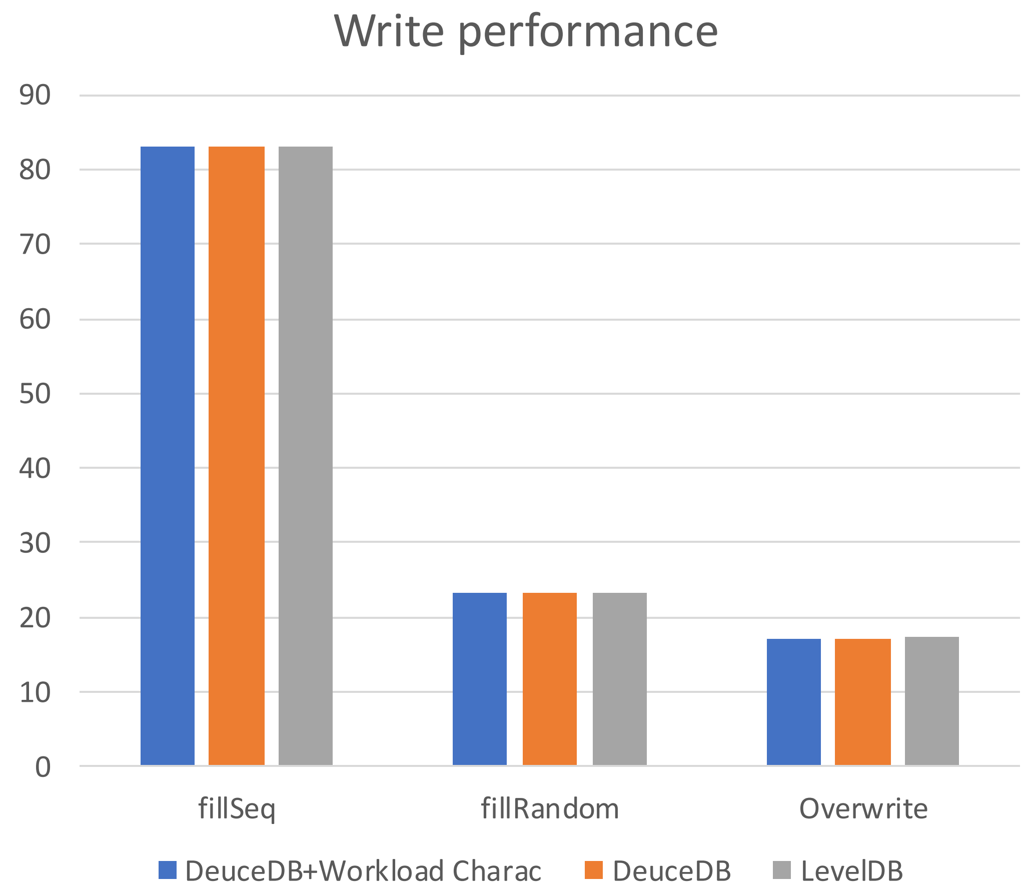
    => disable HotColdKeySeparation



Evaluations

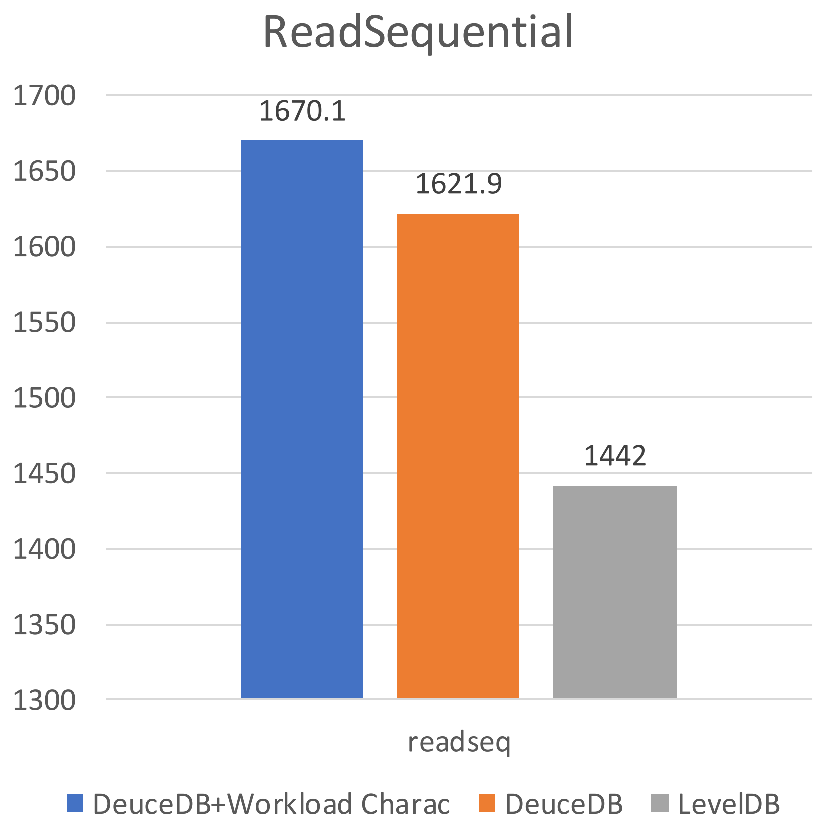
- Hardware
  - CPU: 8 * Intel(R) Core(TM) i7-9700 CPU @ 3.00GHz
  - CPUCache: 12288 KB
  - Keys: 16 bytes each
    Values: 100 bytes each
  - DRAM: 32GB
  - Storage: Samsung 840 evo 1TB M.2 SATA SSD

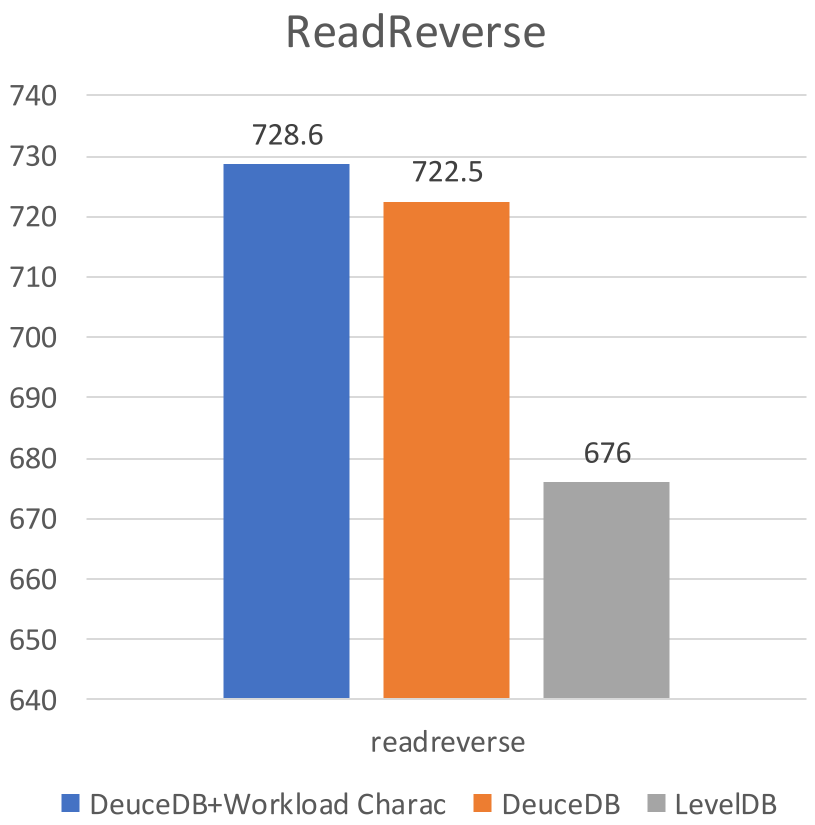
Evaluations



*Evaluations on 5M KV pairs

Evaluations





*Evaluations on 5M KV pairs

Evaluations

- ReadSeq:
- We were able to extract better read performance. An improvement of 3% over our DeuceDB implementation
- This is a 15% improvement over baseline LevelDB.

- Readreverse:
- We were able to extract better read performance. An improvement of 1% over our DeuceDB implementation
- This is an 8% improvement over baseline LevelDB.

- We were able to achieve this without having any impact on Write performance

Q & A

DeuceDB_v2