Modeling *Fast Delete* in Log-Structured Merge (LSM) Trees

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Introduction

Background

Why use LSM trees?

Fast Ingestion | Competitive Reads | Good Space Utilization

Deletes in LSM trees

- Insert **tombstone** to "delete"
- Tombstones invalidate but do not remove entries
- No guarantees for deletion time
- Invalid entries increase **space amplification**, impairing performance
- ***Fast Delete* (FADE)** persists deletes by enforcing time bounds (*delete persistence thresholds*) on garbage collection (*compactions*)

Objective

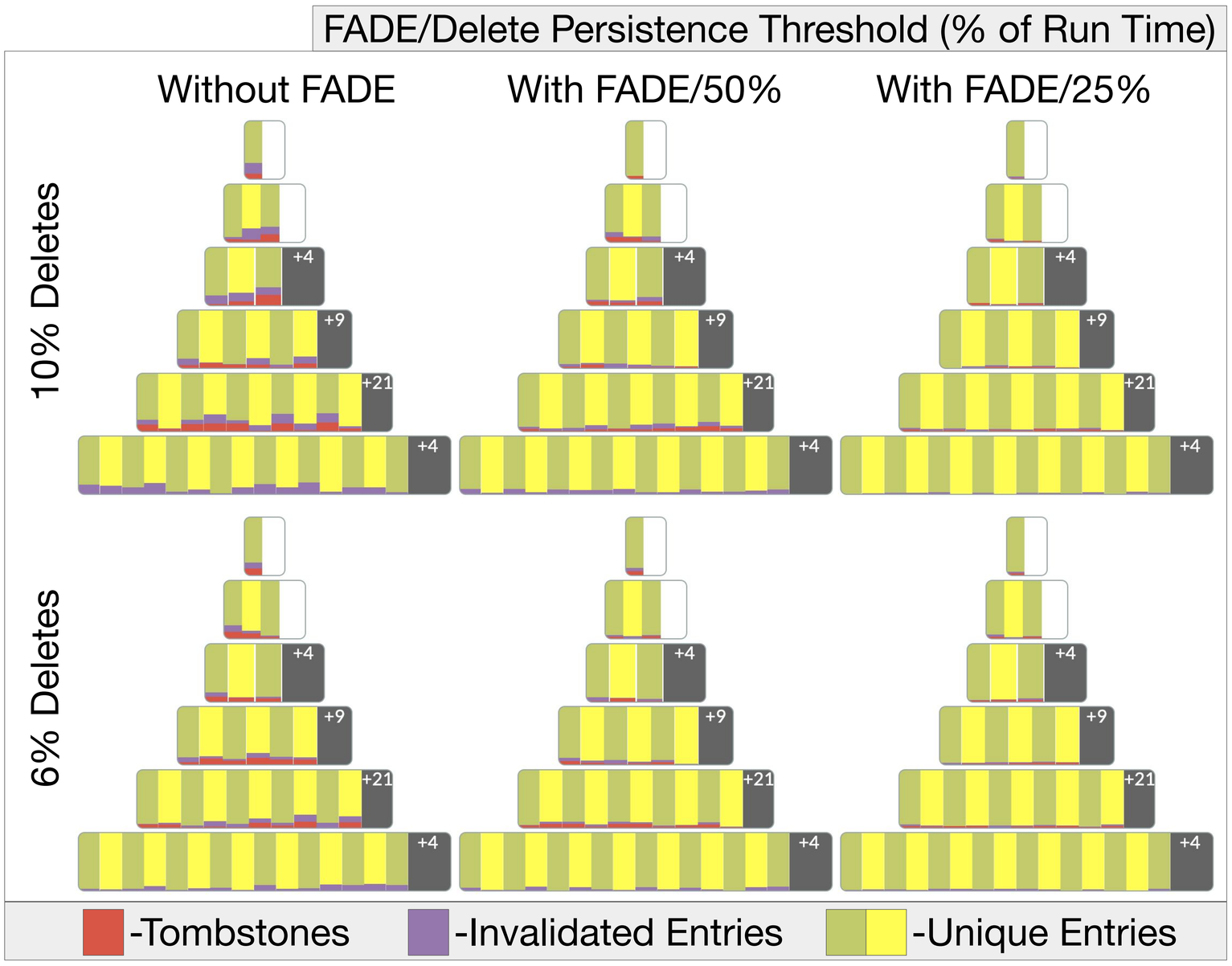
Build web interface visualizing FADE's performance implications as workload varies

Methods

- Build dynamic, file-specific tombstone visual (Fig. 1)
- Populate emulated LSM trees for six workload configurations
- Validate visualization by comparing with experimental results (Fig. 2)
- Parameters varied:
  - Use of FADE (Without FADE, With FADE/50%, With FADE/25%)
  - Proportion of deletes in workload (6%, 10%)

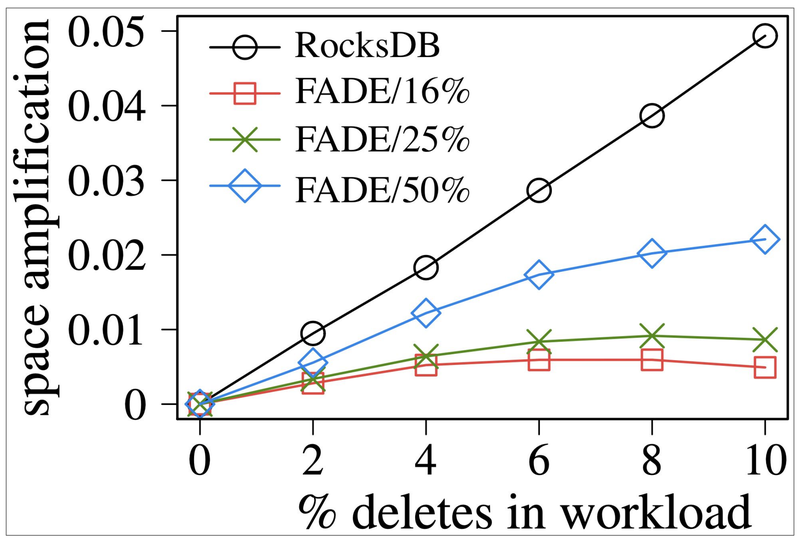
Results

Fig. 1: Tombstone density and distribution (LSM emulation)



Discussion

Fig. 2: Space amp. vs. % deletes [1]



Conclusions

- Without FADE, almost all tombstones remain in the LSM tree
- With FADE, tombstones are persisted, reducing space amplification especially when deletes increase in the workload
- Lower delete persistent thresholds persist more tombstones

Limitations

- Static inputs to vary in future:
  - Presence of updates
  - Support for different key distributions (currently support uniform distribution only)

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