CS 265

Stratos Idreos

BIG DATA SYSTEMS

NoSQL | Neural Networks | Image AI | LLMs | Data Science

Logistics

Systems projects and Labs are active.

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Action Items for now

Readings and go to labs to start getting familiar with systems projects.

preparation

Get familiar with the very basics of traditional database architectures:
Architecture of a Database System. By J. Hellerstein, M. Stonebraker and J. Hamilton. Foundations and Trends in Databases, 2007

Get familiar with very basics of modern database architectures:
The Design and Implementation of Modern Column-store Database Systems. By D. Abadi, P. Boncz, S. Harizopoulos, S. Idreos, S. Madden. Foundations and Trends in Databases, 2013

Get familiar with the very basics of modern large scale systems:
Massively Parallel Databases and MapReduce Systems. By Shivnath Babu and Herodotos Herodotou. Foundations and Trends in Databases, 2013

first readings

The Periodic Table of Data Structures.
Stratos Idreos, Kostas Zoumpatianos, Manos Athanassoulis, Niv Dayan, Brian Hentschel, Michael S. Kester, Demi Guo, Lukas Maas, Wilson Qin, Abdul Wasay, Yiyou Sun.
IEEE Data Engineering Bull. Sep, 2018

Design Continuums and the Path Toward Self-Designing Key-Value Stores that Know and Learn.
Stratos Idreos, Niv Dayan, Wilson Qin, Mali Akmanalp, Sophie Hilgard, Andrew Ross, James Lennon, Varun Jain, Harshita Gupta, David Li, and Zichen Zhu. Proceedings of CIDR Conference on Innovative Data Systems Research, 2019.

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Readings for NoSQL research & project and mathematical systems modelling

Monkey: Optimal Navigable Key-Value Store. Niv Dayan, Manos Athanassoulis, Stratos Idreos. In Proceedings of the ACM SIGMOD International Conference on Management of Data, 2017

Dostoevsky: Better Space-Time Trade-Offs for LSM-Tree Based Key-Value Stores via Adaptive Removal of Superfluous Merging. Niv Dayan, Stratos Idreos. In Proceedings of the ACM SIGMOD International Conference on Management of Data, 2018

The Log-Structured Merge-Bush & the Wacky Continuum. Niv Dayan, Stratos Idreos. In Proceedings of the ACM SIGMOD International Conference on Management of Data, 2019

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Reading SysML research & project

μ-TWO: 3x Faster Multi-model Training with Orchestration and Memory Optimization, Sanket Purandare, Abdul Wasay, Animesh Jain, Stratos Idreos, Conference on Machine Learning and Systems (MLsys), 2023

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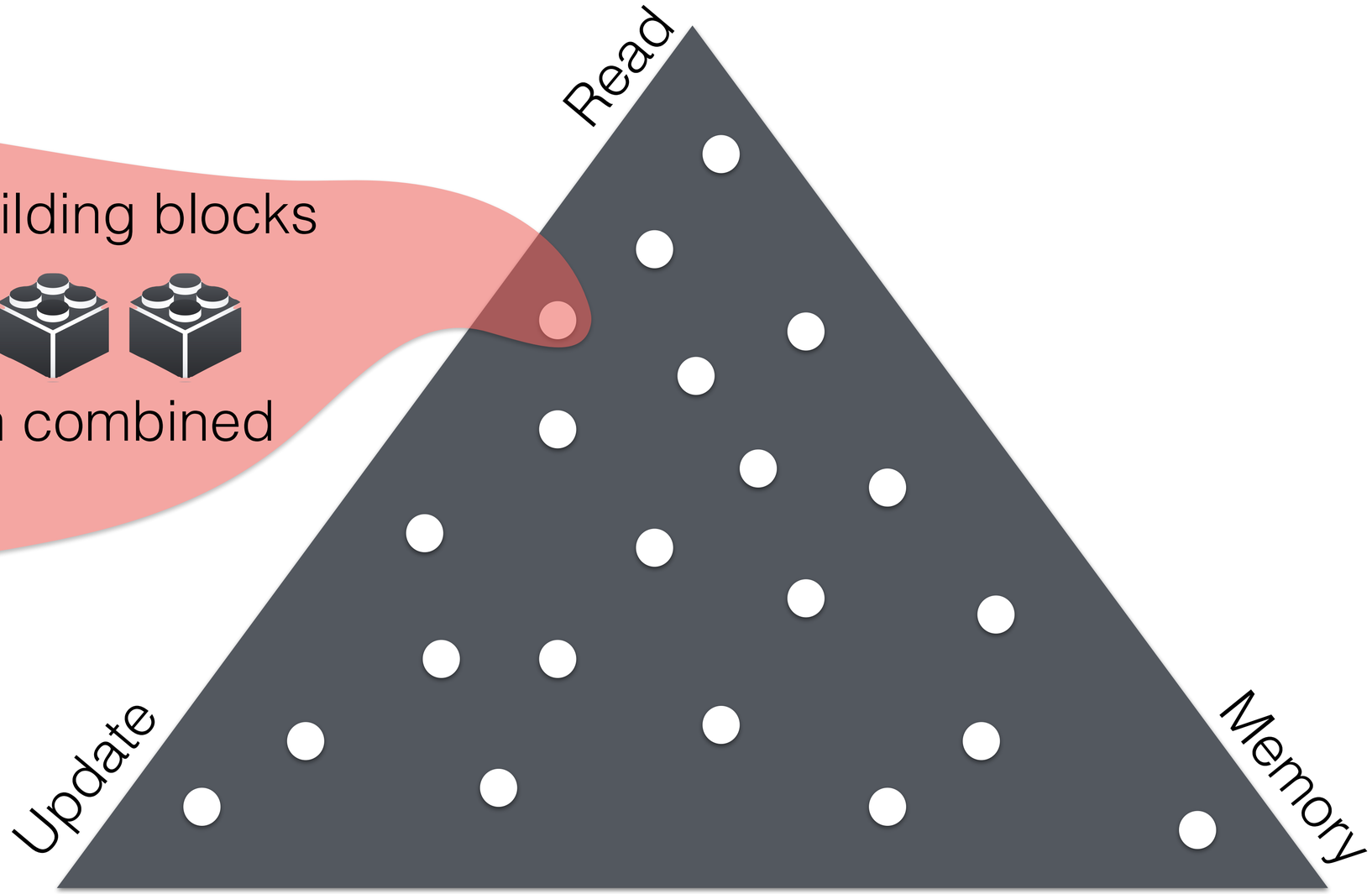
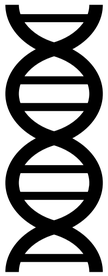
we will add 4 more in the next 2 weeks

fundamental building blocks

properties when combined





DESIGN SPACE

COST SYNTHESIS

WHAT-IF

NoSQL Key-value Stores

RocksDB Google BigTable mongoDB SQLite in

amazon DynamoDB cassandra APACHE HBASE

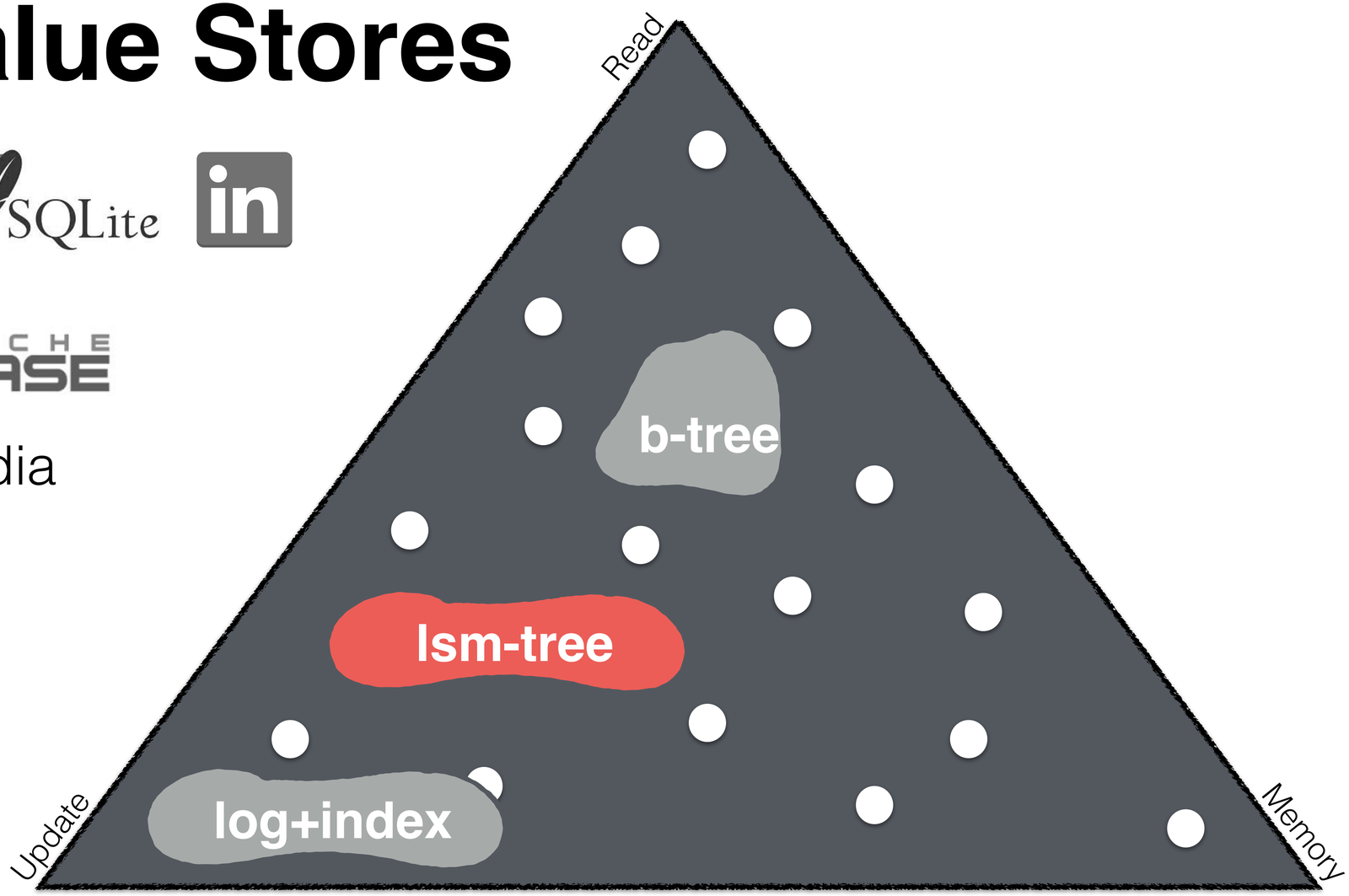
machine learning social media

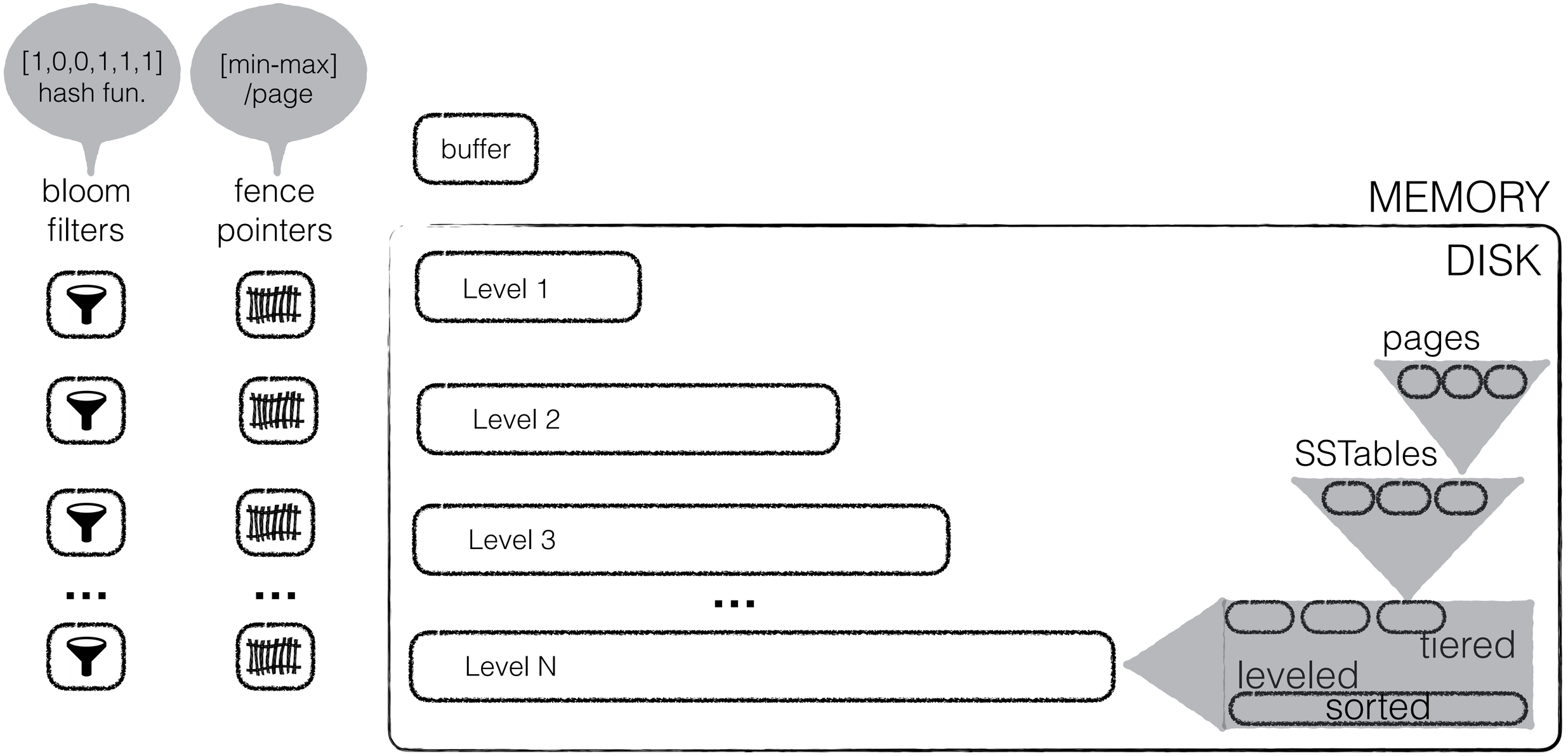
smart homes web browsers

phones web-based apps

security health devices

graphs analytics




[1,0,0,1,1,1]
hash fun.
[min-max]
/page
bloom
filters
fence
pointers
buffer
MEMORY
DISK
Level 1
Level 2
Level 3
...
Level N
pages
SSTables
tiered
leveled
sorted

Today/This week

Advanced LSM-tree/Storage designs.
We will see that “advanced research is fundamentally simple”

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Intro to Step 2 of self-designing systems: cost synthesis (math & ML).

BITS PER ENTRY IN FILTERS: OPTIMIZED OUT

Monkey: **O**ptimal **N**avigable **Key**-Value Store @SIGMOD2017

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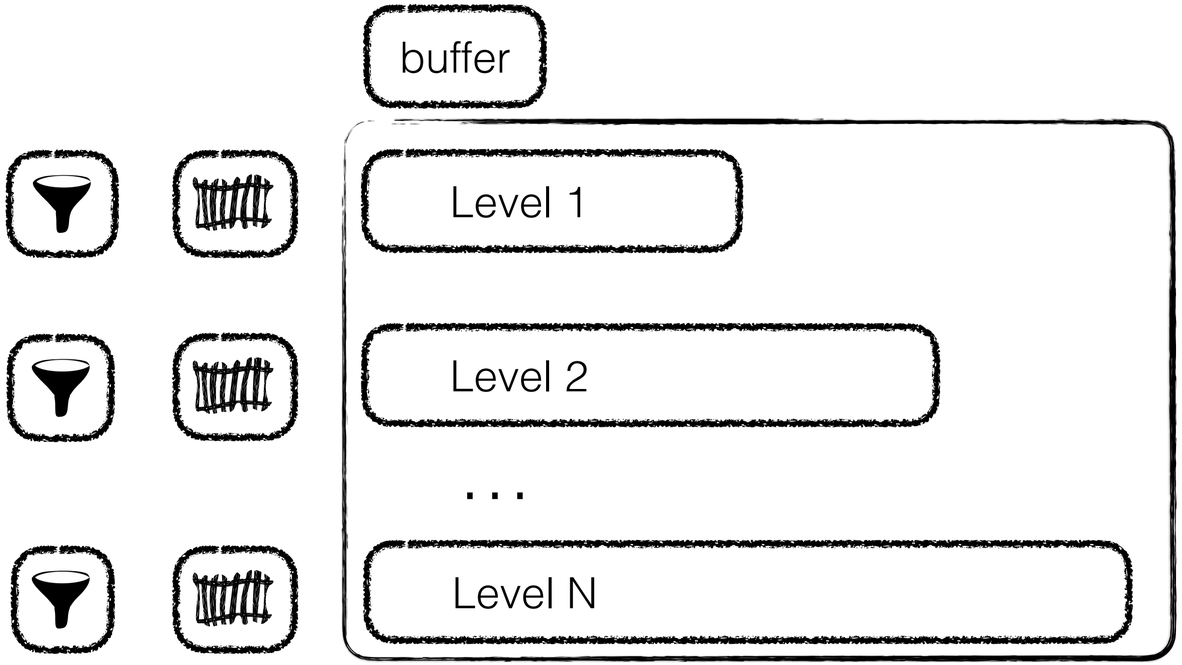

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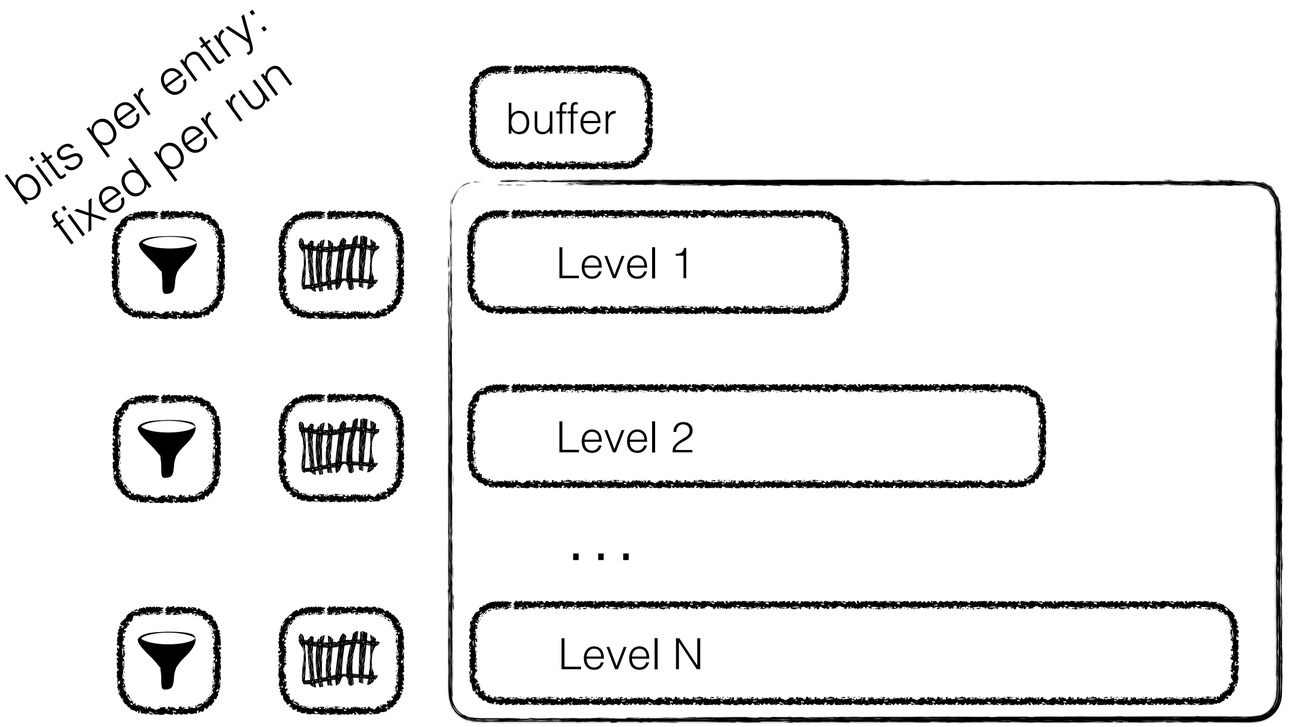

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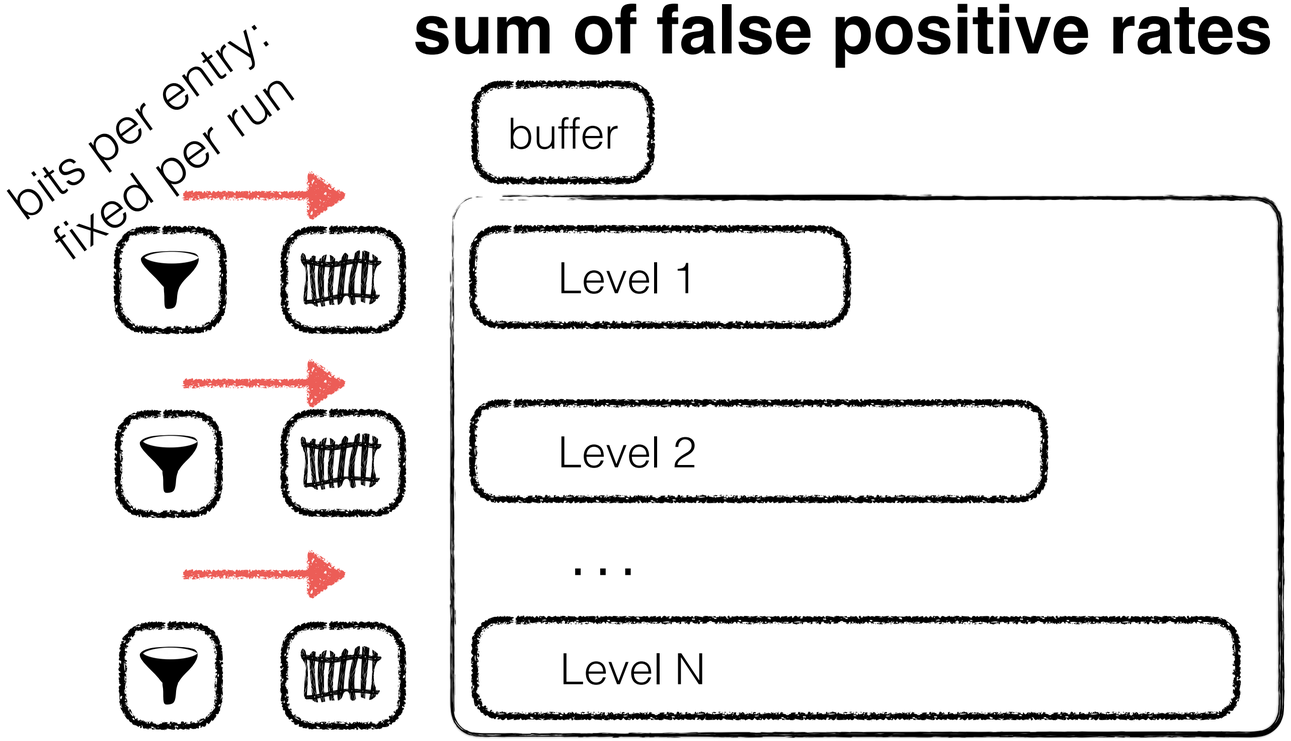
worst lookup cost:
sum of false positive rates



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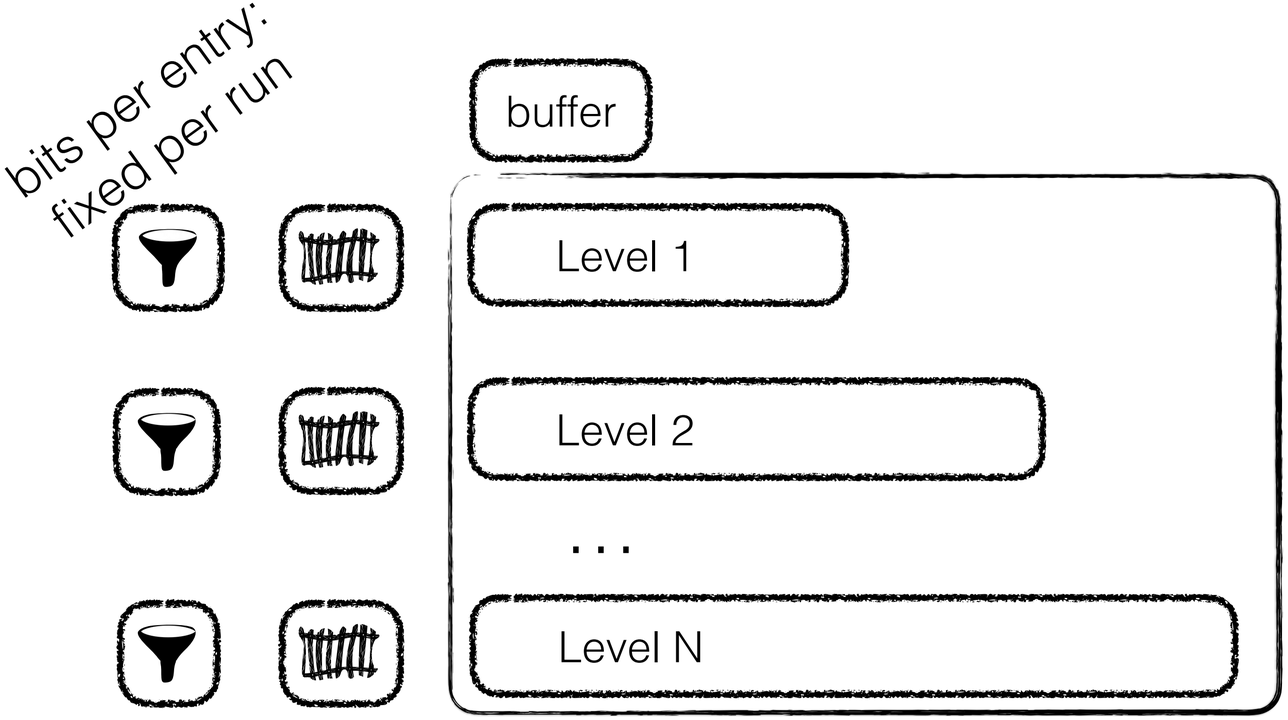
the same memory budget
is more impactful at smaller levels



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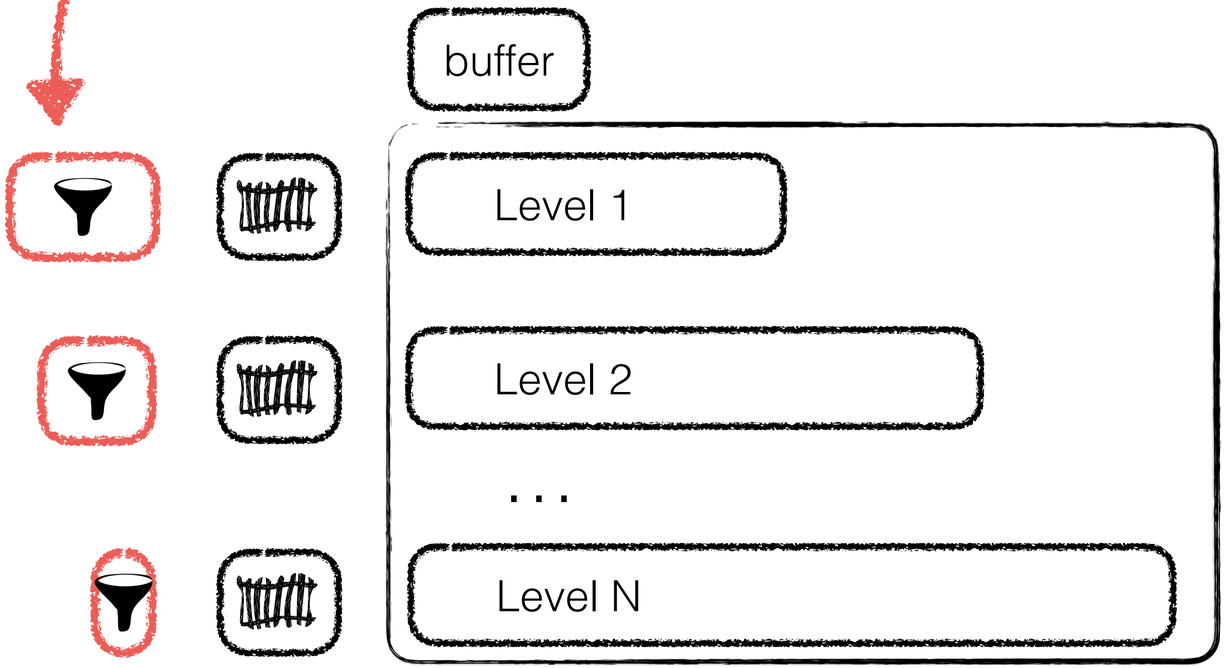

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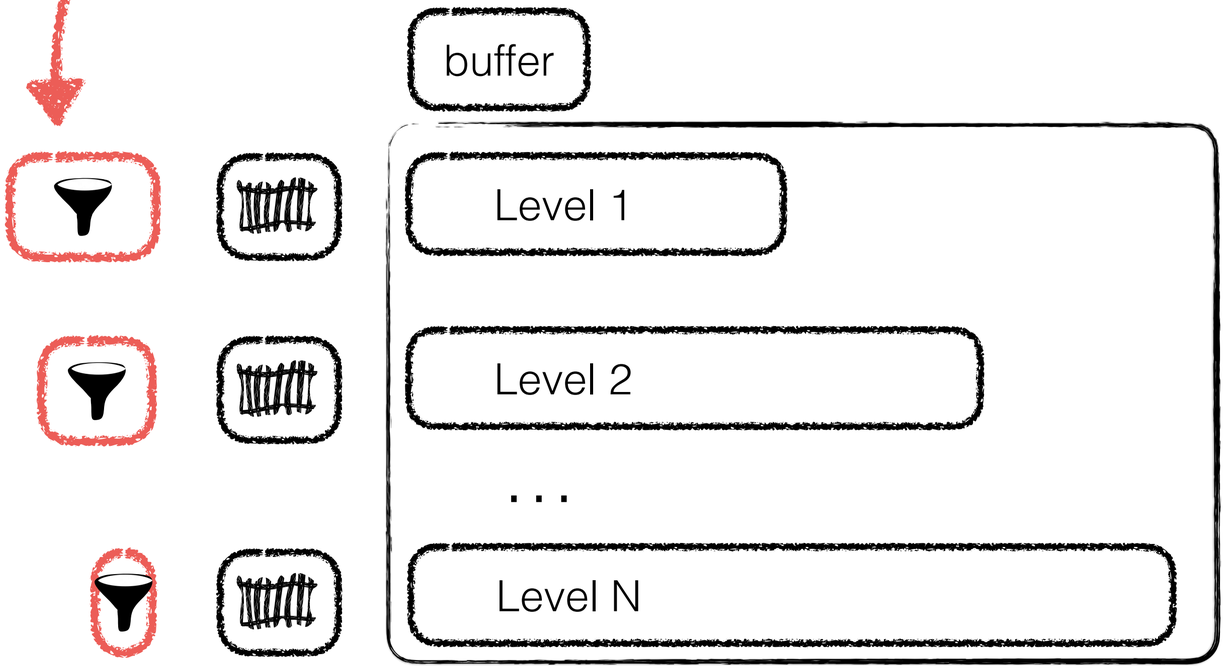

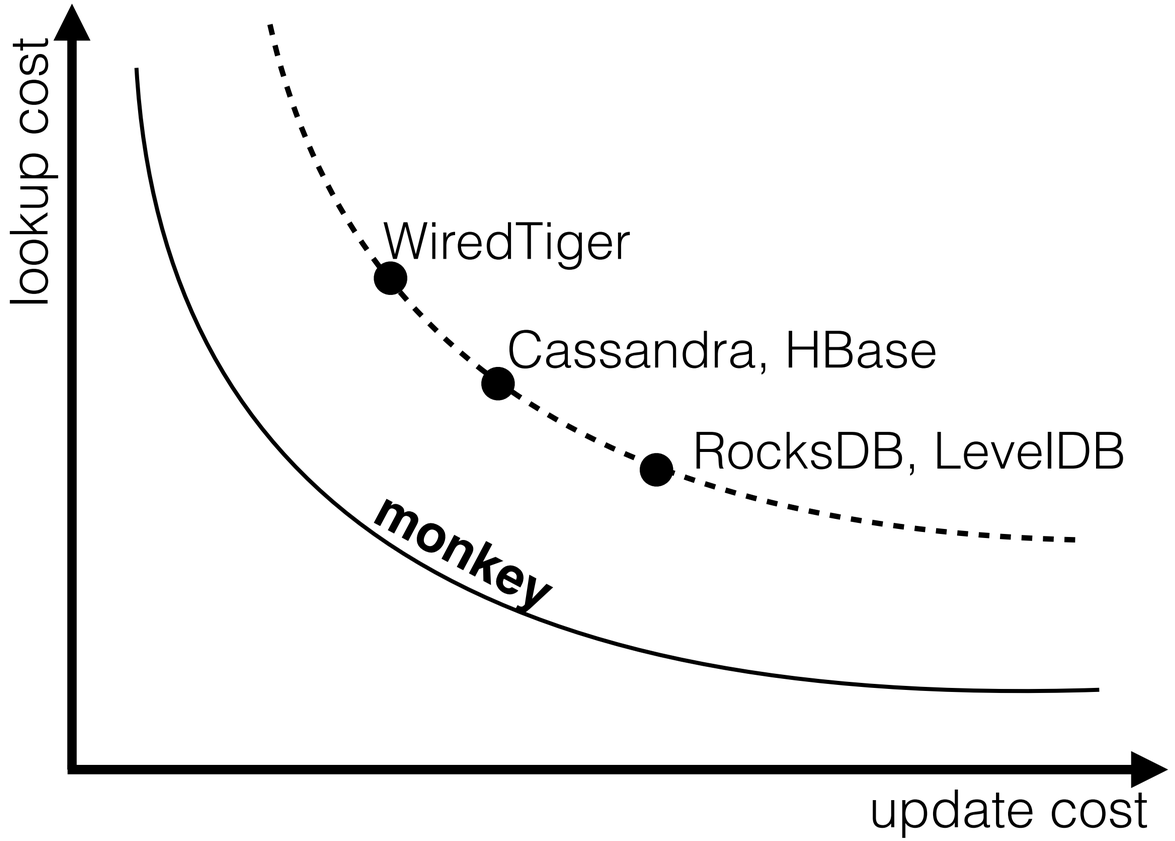

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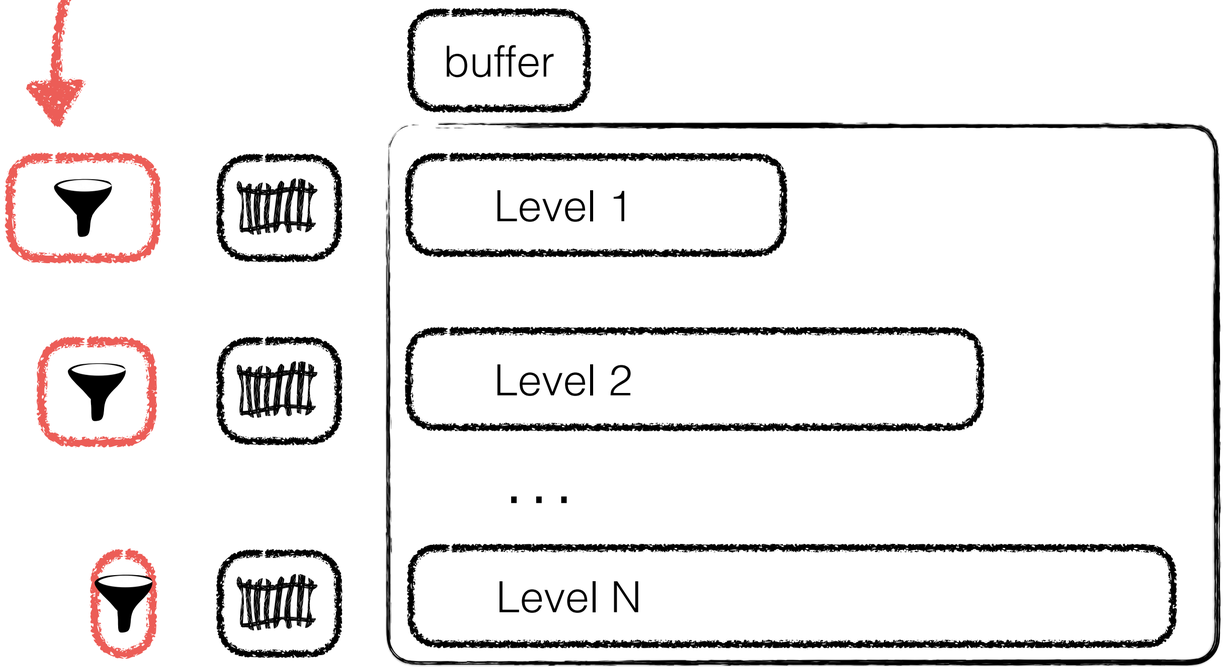

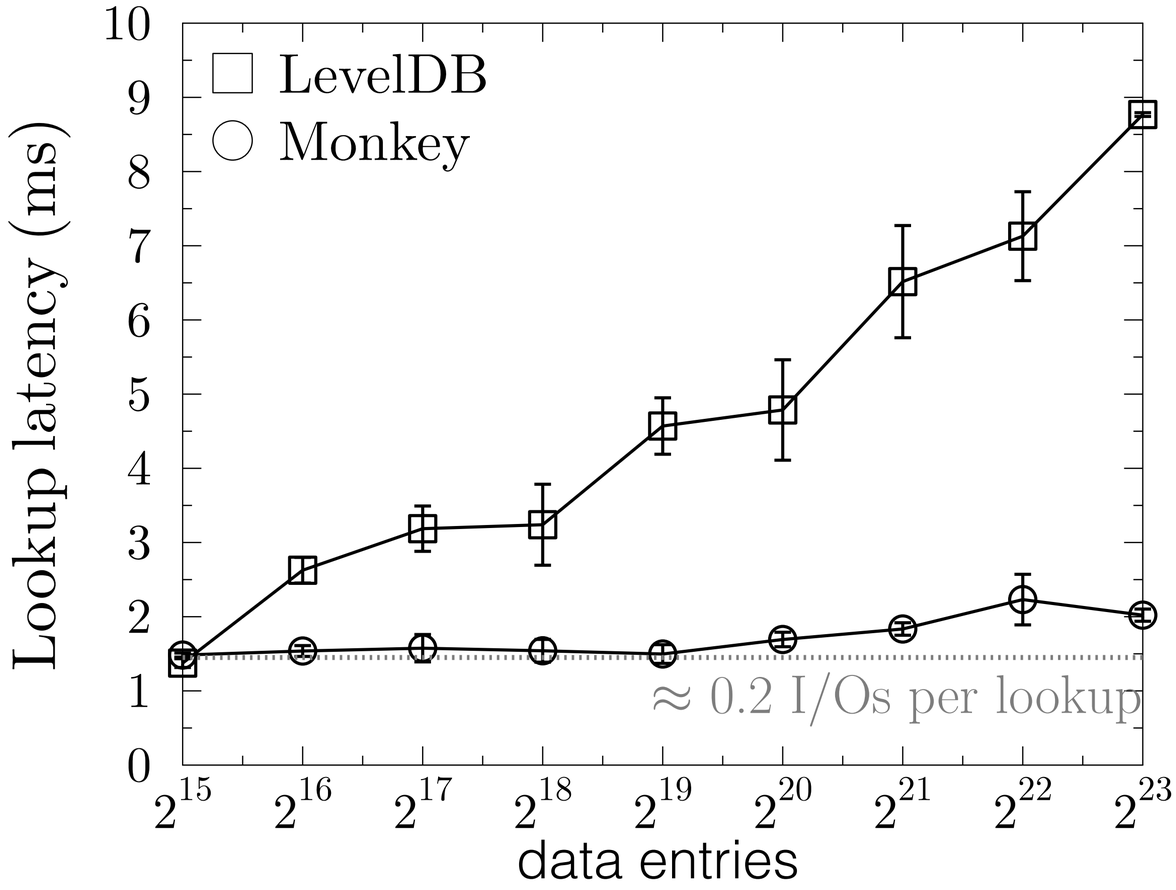

uniform, zero result, point queries, entry size=1KB

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