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Aeris Filter

Robust range filtering through adaptivity

SIGMOD 2026

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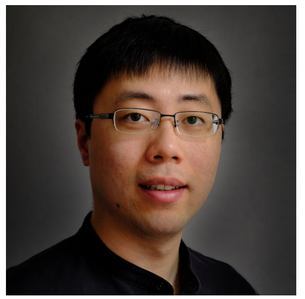
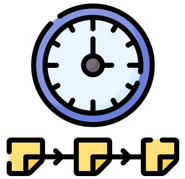


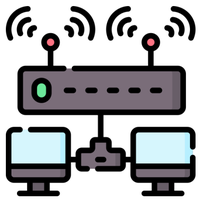

Range queries are ubiquitous

Range Query
Get all keys in range[a, b]

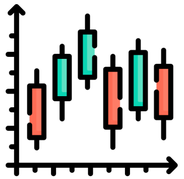
OLAP



Time-series



Networking

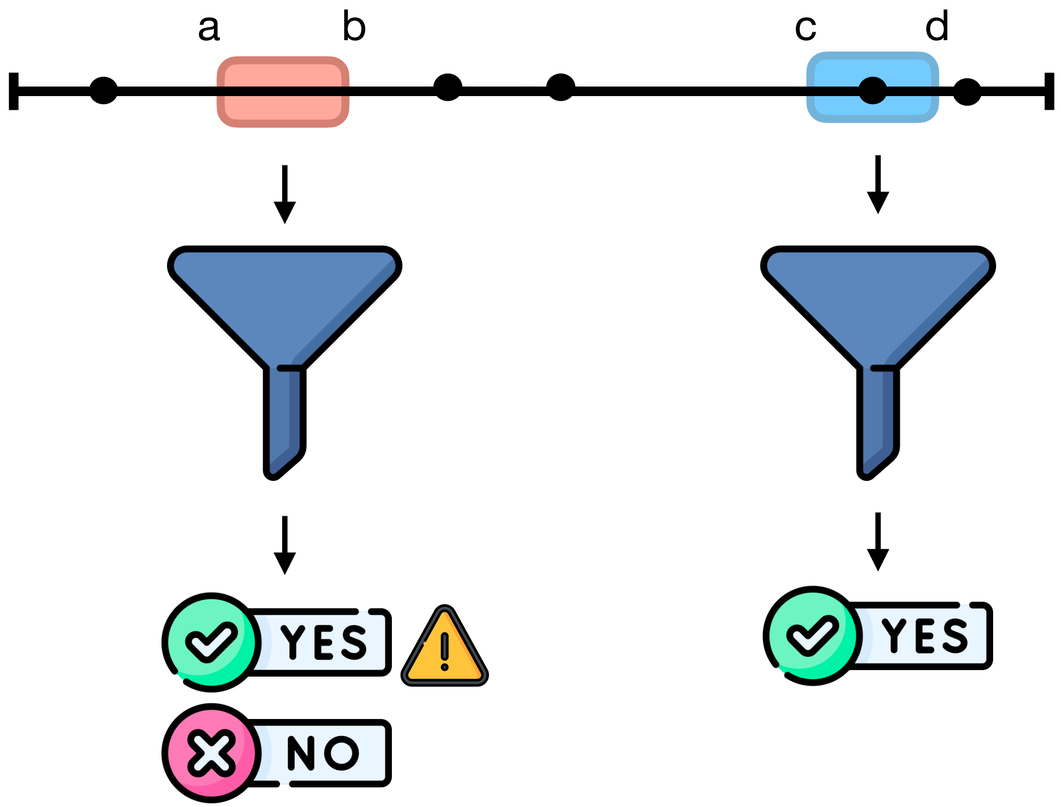


Financial Analysis

Bioinformatics

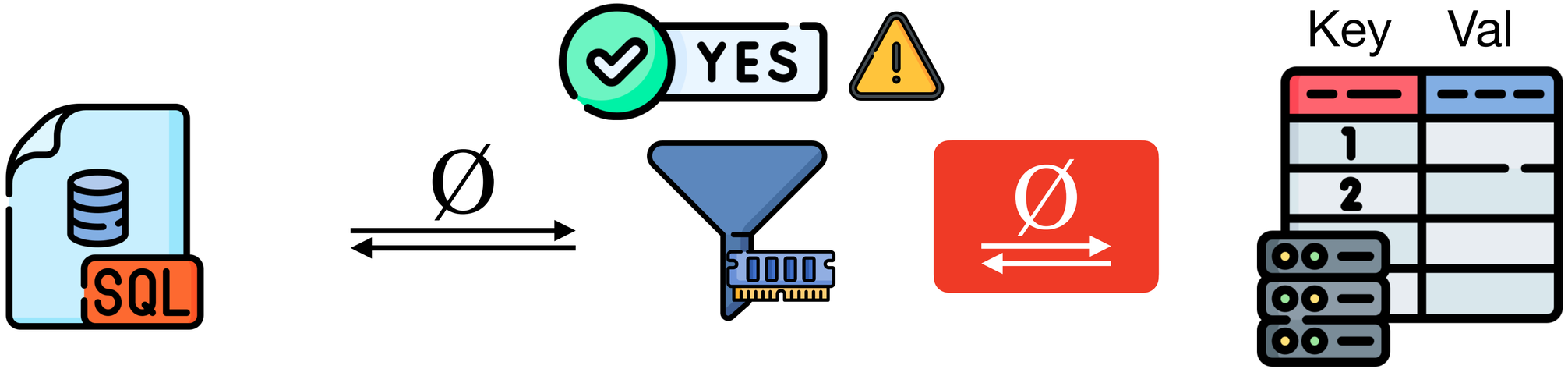
Spatial queries

What is a range filter?

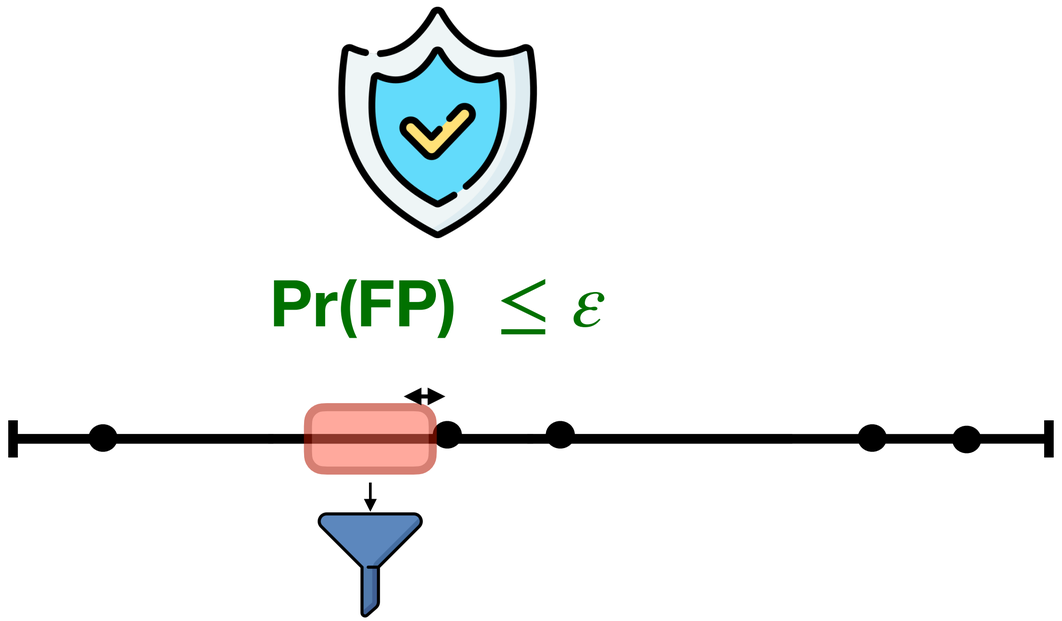


Range emptiness query: Are there any elements in the queried range?

False positives result in disk accesses



Spatially robust range filters

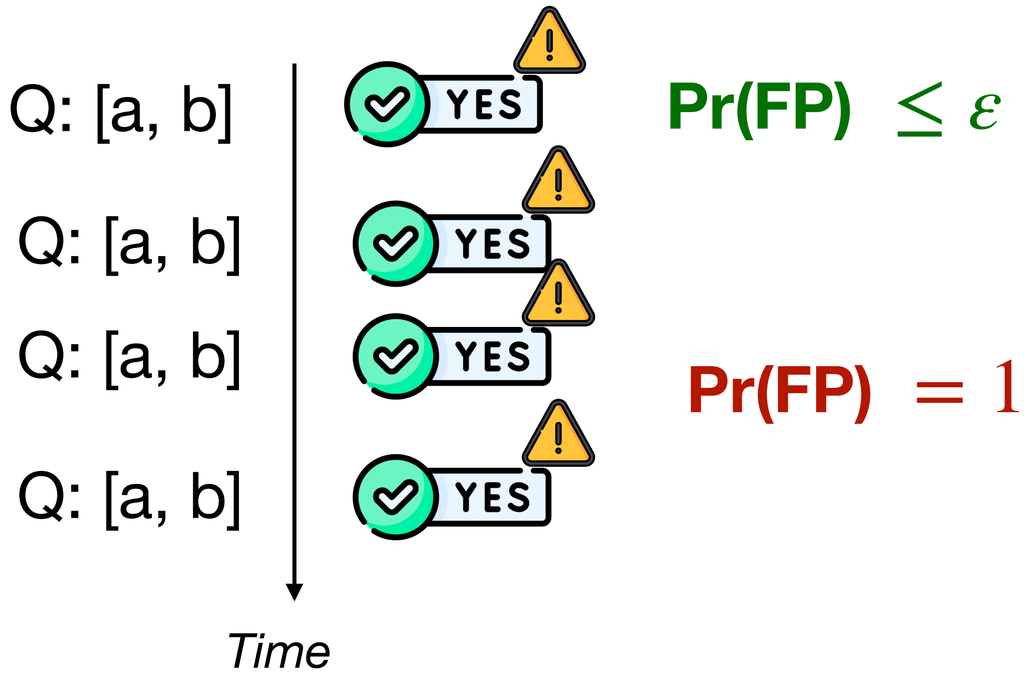


Rosetta	**Grafite**	**Memento**
SIGMOD 2020	SIGMOD 2024	SIGMOD 2025

Spatially robust: Bounded false positive rate, even under spatial skew

Non-robust: Unbounded false positive rate under spatial skew

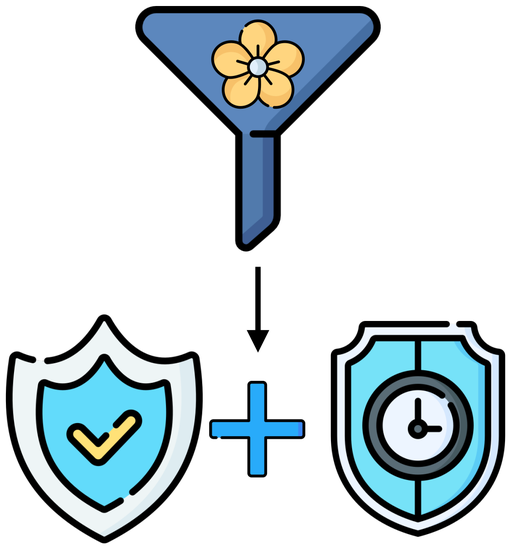
Spatial robustness ≠ Temporal robustness



Spatial robustness only hold for a single query in isolation

Temporal robustness needed to ensure guarantees hold across repeated queries

Aeris Filter

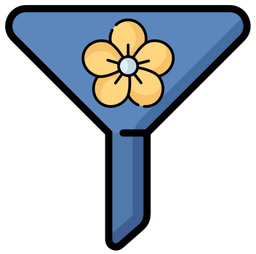


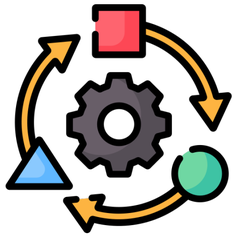
Spatial and **temporal** robustness

10x lower false positives on skewed workloads

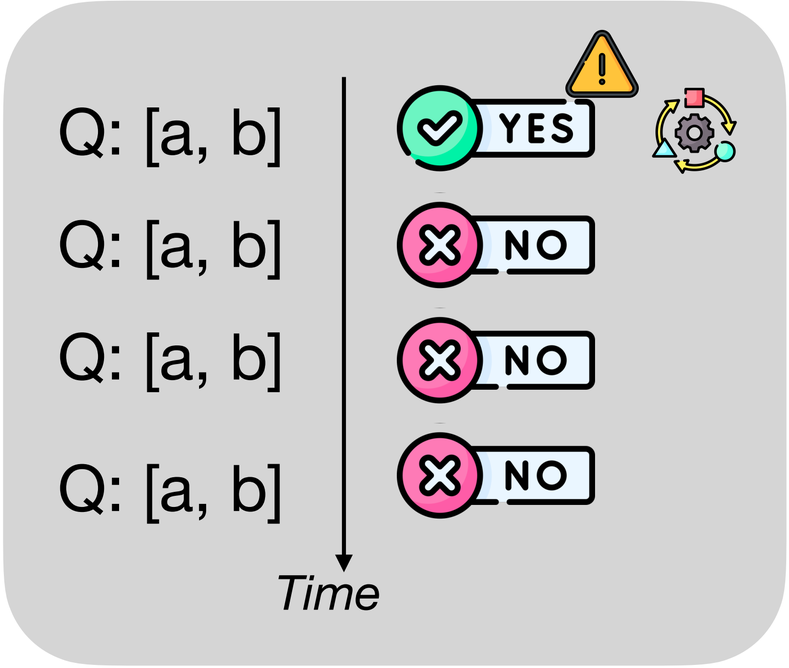
8x higher throughput on adversarial workloads

Based on Memento range filter
[ED, 2024]





Implements adaptivity
[BFG+, 2018]



Spatial + Temporal Robustness:

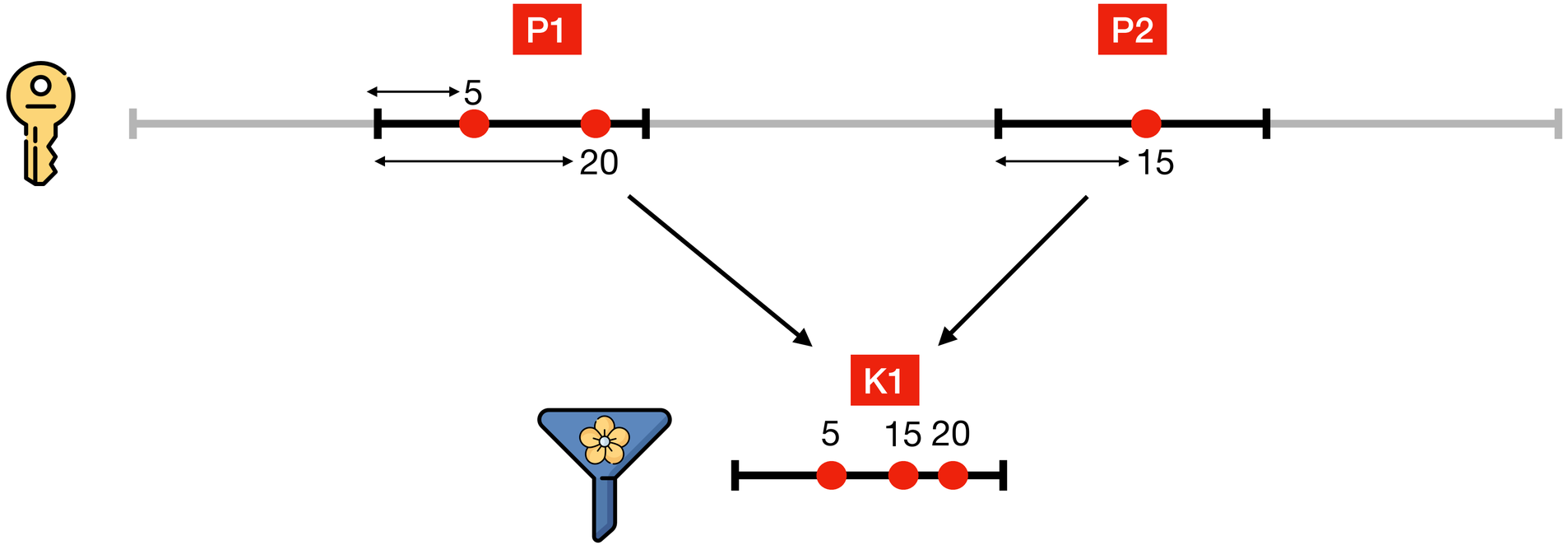
Pr(FP) $\leq \varepsilon$

Negligible space overhead:
1 extra metadata bit per item over Memento

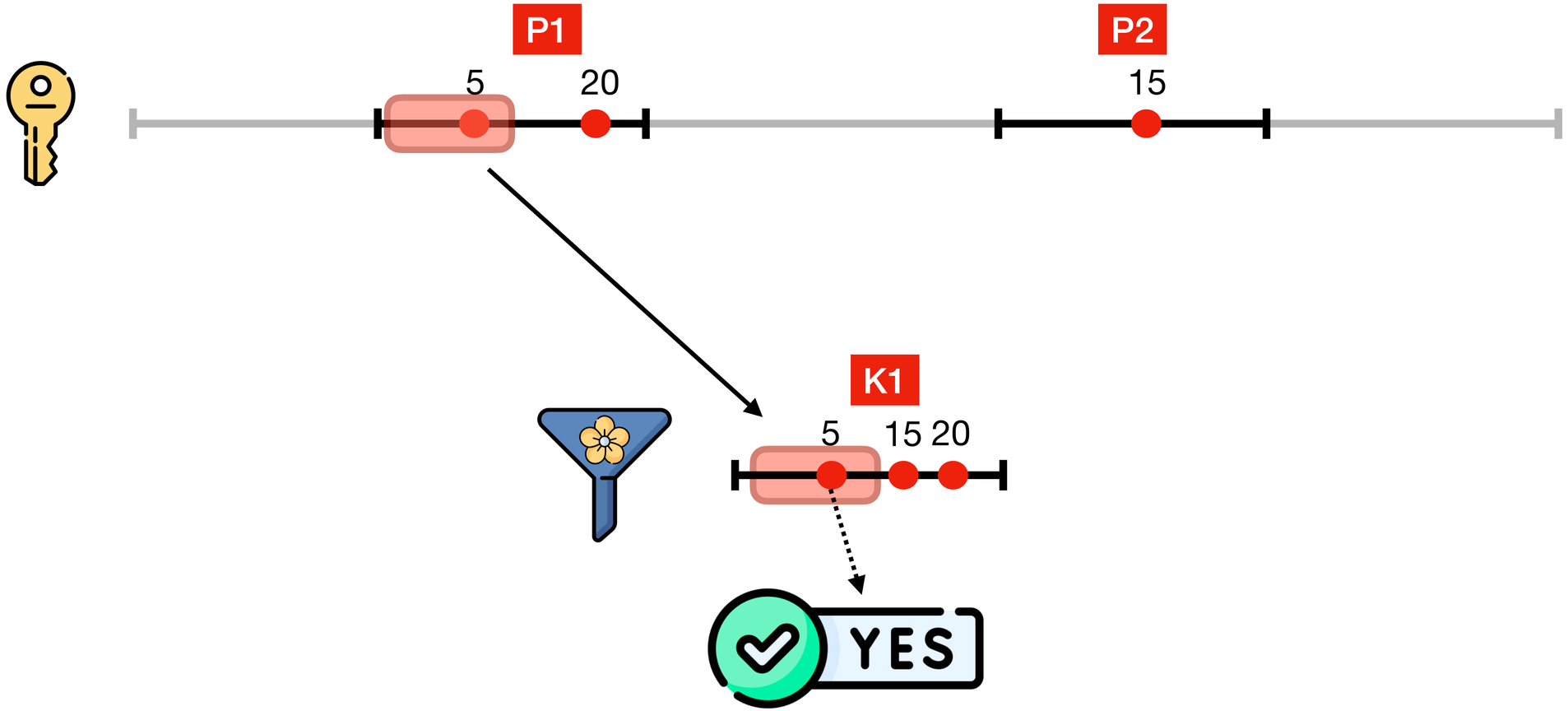
[BFG+2018]: Bender, M. A., Farach-Colton, M., Goswami, M., Johnson, R., McCauley, S., & Singh, S. (2018, October). Bloom filters, adaptivity, and the dictionary problem. In *2018 IEEE 59th Annual Symposium on Foundations of Computer Science (FOCS)* (pp. 182-193). IEEE.

[ED, 2024]: Eslami, N., & Dayan, N. (2024). Memento filter: A fast, dynamic, and robust range filter. *Proceedings of the ACM on Management of Data*, *2*(6), 1-27.

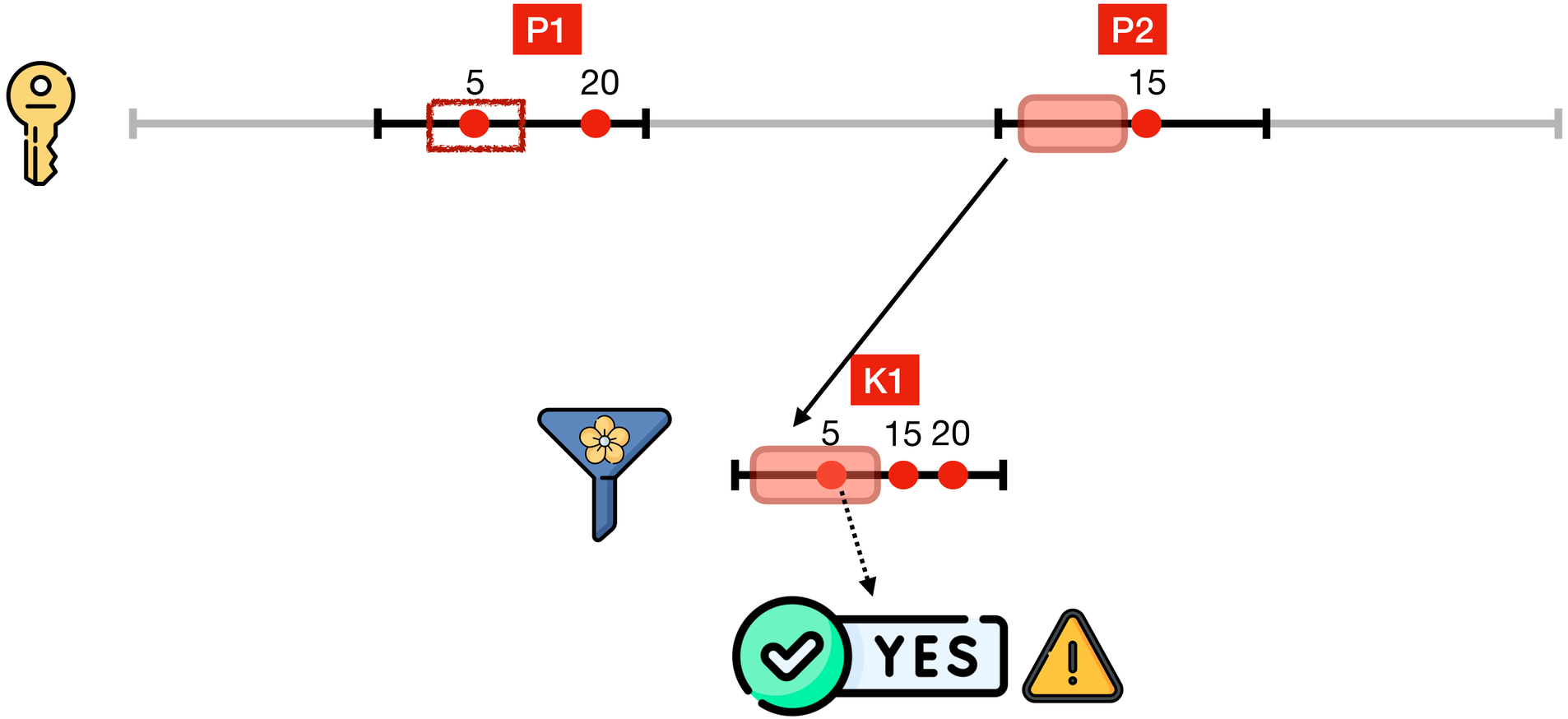
Memento combines partition key offsets



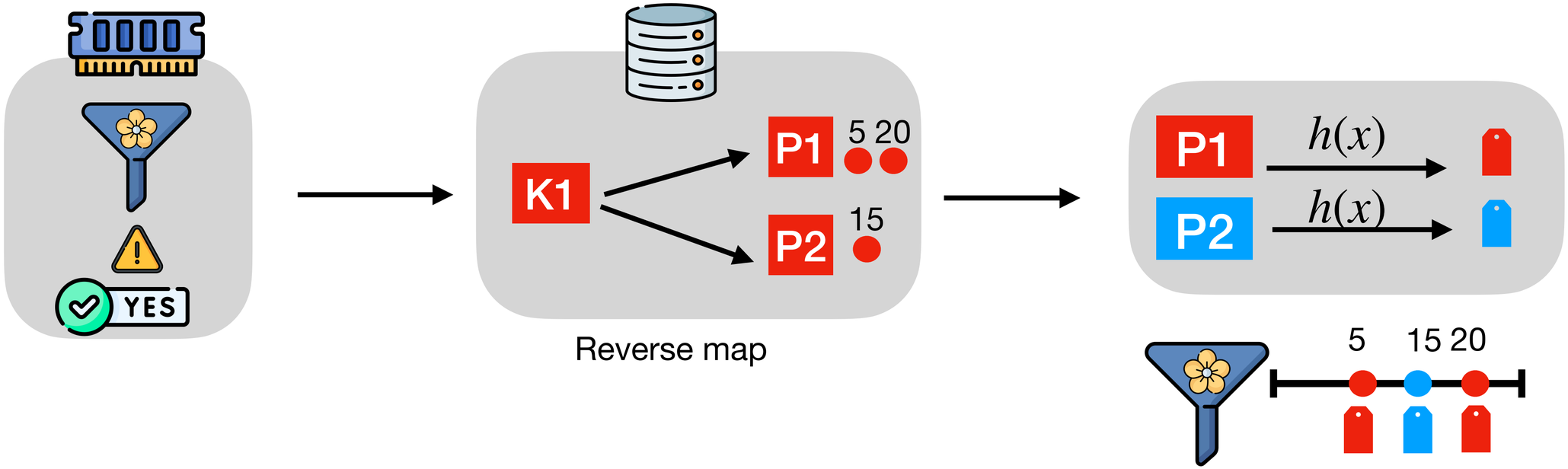
Queries are answered in filter space



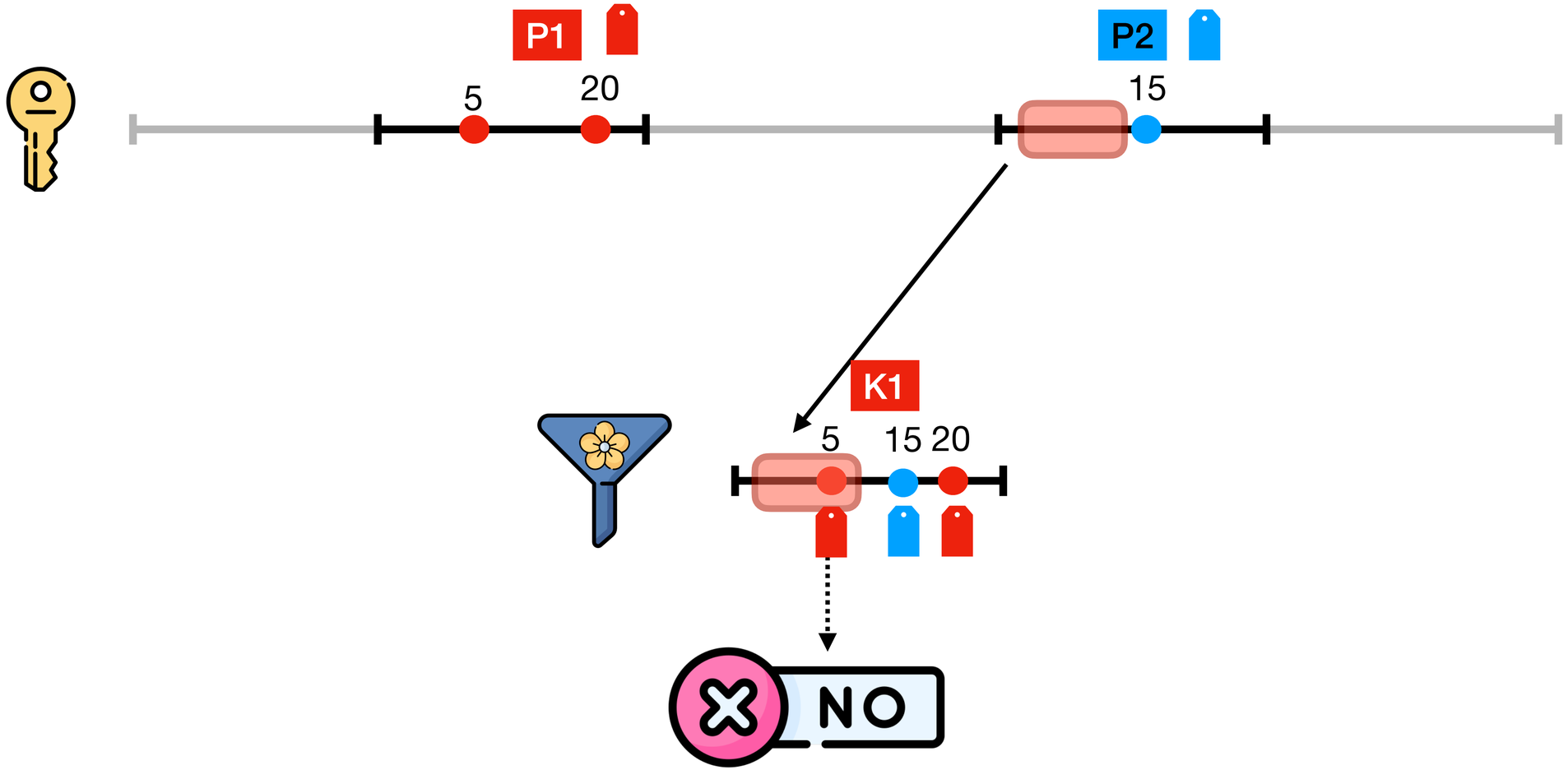
Where false positives come from



How Aeris filter adapts to false positives



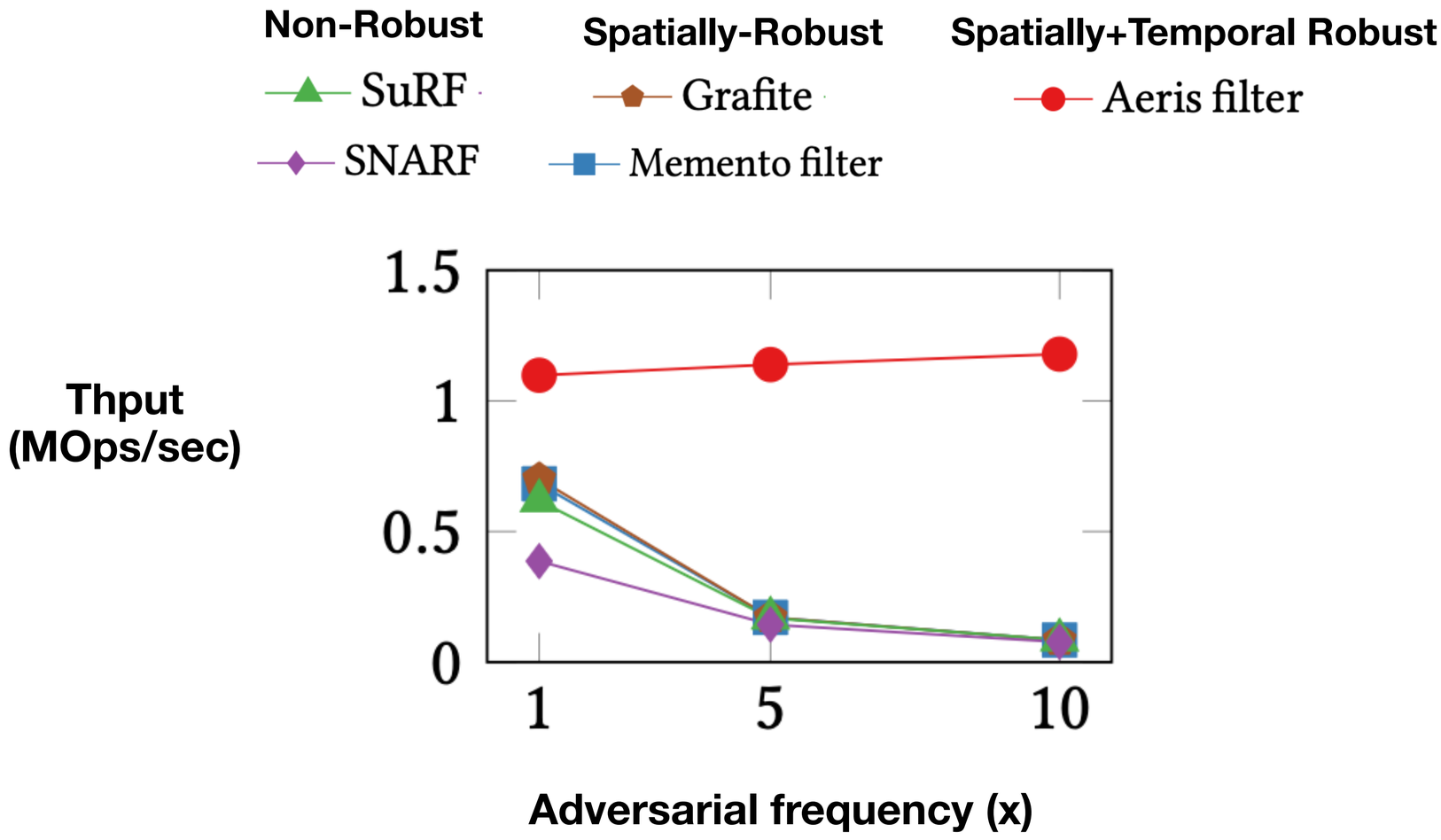
Disambiguating offsets resolves false positives



Evaluation setup

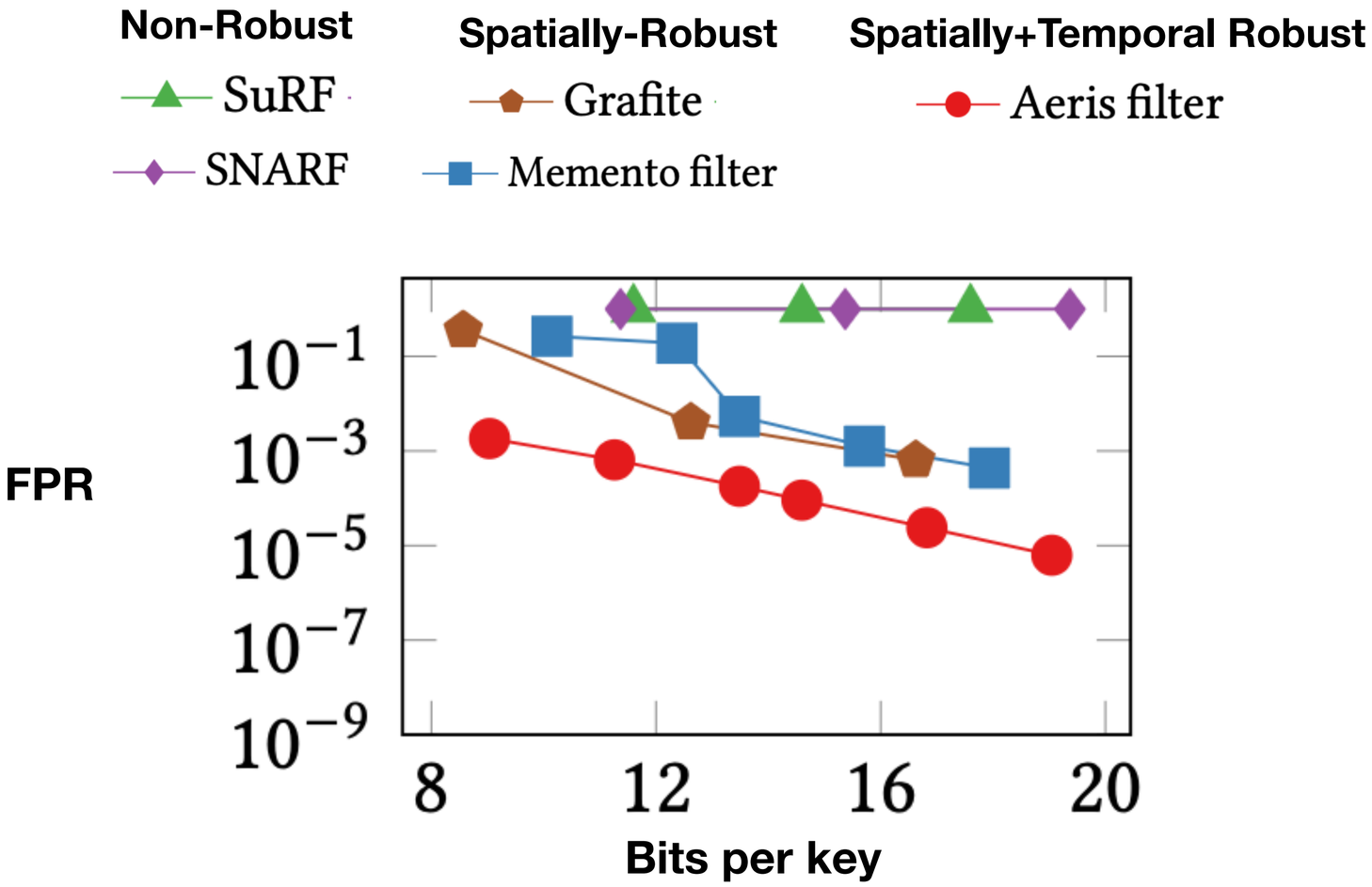
- WiredTiger database (100 million pairs of 64-bit keys, 512-bit values)
- Tested for point queries (R=1), short range queries (R=32) and long range queries (R=1024)
- All filters tested on 100 million queries with configured false positive rate $\epsilon = 2^{-9}$
- Filters
  - **Non robust:** SNARF, SuRF
  - **Spatially robust:** Grafite, Memento
  - **Spatially and temporally robust**: Aeris

System throughput on adversarial workload



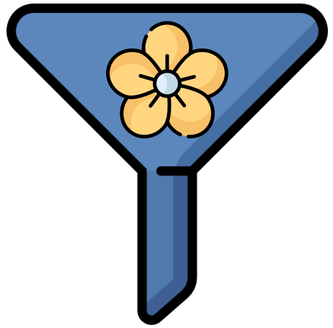
(Y-Axis: Linear scale, higher is better)

Temporal robustness at negligible space cost



(Y-Axis: Log scale, lower is better)

Takeaways



- **If your workload has any skew, Aeris is the right filter!**
- Provides both **spatial and temporal robustness**
  - **10x lower FPR** on skewed workloads,
  - **8x higher throughput** on adversarial workloads
  - Deamortizes filter expansions for **3x faster expansions**
  - Negligible space overhead
- **Code**: https://github.com/saltsystemslab/AerisFilter