SMOKE: Fine-Grained Lineage Capture at Interactive Speed

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Introduction

Lineage at the core of many applications
Visualization, debugging, diagnostics, profiling, why-not, interpretability, …

Overhead of lineage capture can cripple query engine performance

Smoke introduces principles to reduce overhead from >100x slowdown to ~1.3x slowdown

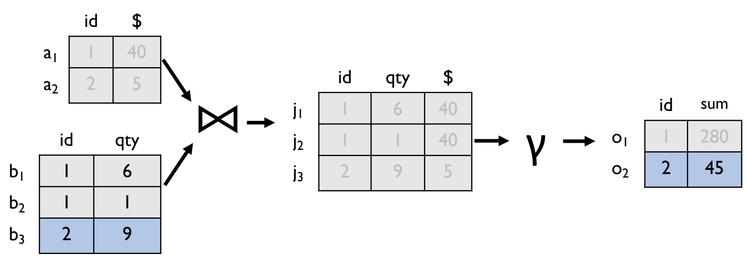
Related Approaches

Considerable redundant work

Lazy

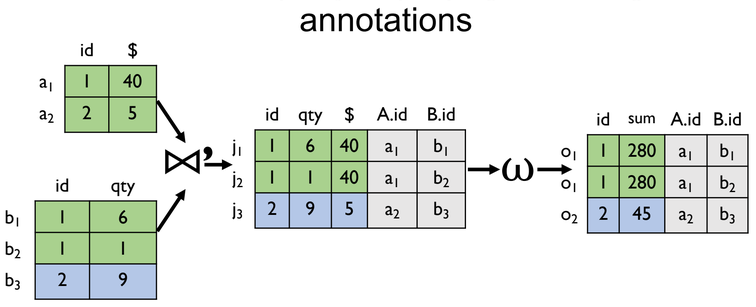
Rewrite lineage query into SQL

$\text{backward\_trace}(o_1, B) = \sigma_{id=p_1}(B)$



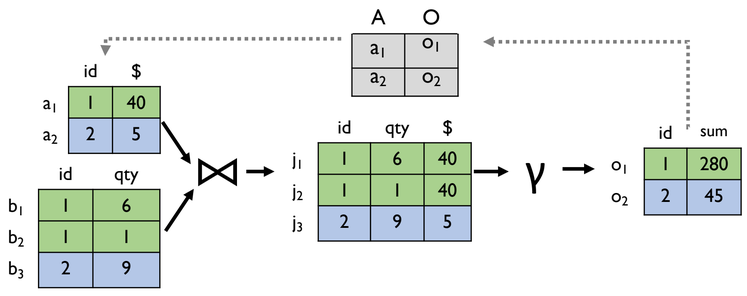
Logical Denormalized

Rewrite base query to propagate lineage as annotations



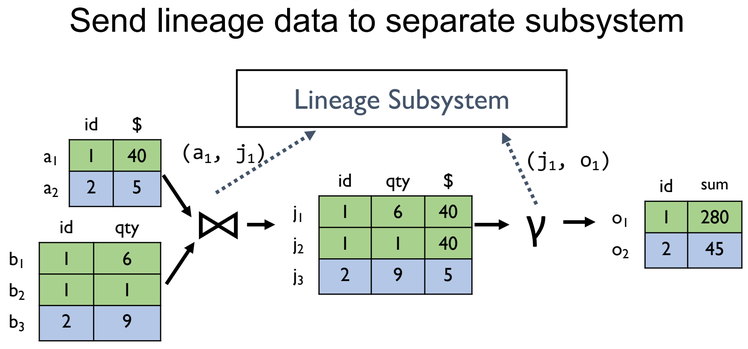
Logical Normalized

Driver rewrites query to propagate lineage as normalized relations



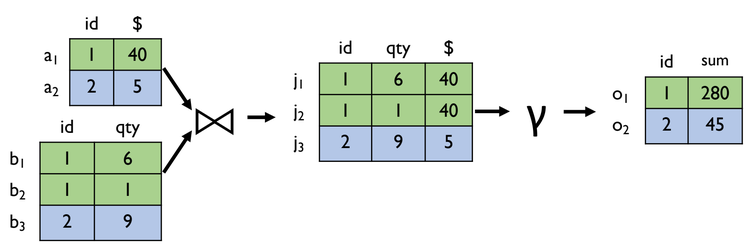
Physical

Send lineage data to separate subsystem

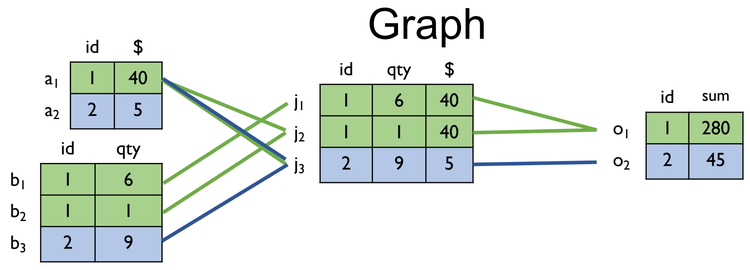


Lineage Capture

$\gamma_{id,sum(qty*\$)}(A \bowtie B)$



Materialize Lineage Graph



SMOKE Overview

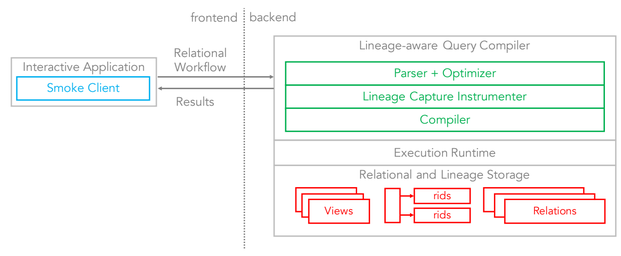
4 Design Principles

P1. Tight Integration
Instrument operators to write lineage idxs

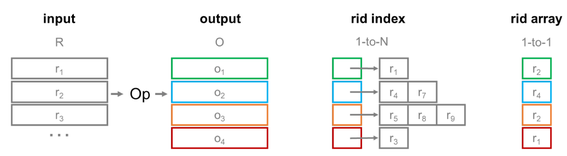
P2. Reuse work
Lineage indexes ~ Hash tables
Intra-plan hash table reuse

P3. Apriori Knowledge
Don't capture if not used

P4. Lineage Consumption
Push computation into lineage capture



Indexes are Integer Arrays

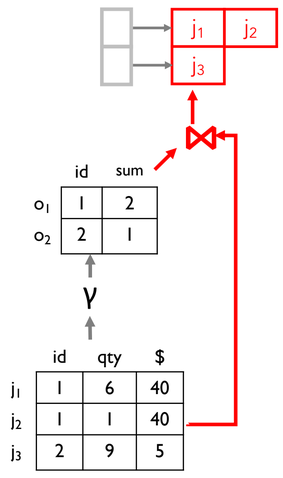


Example: Group-By

Two Lineage Capture Paradigms

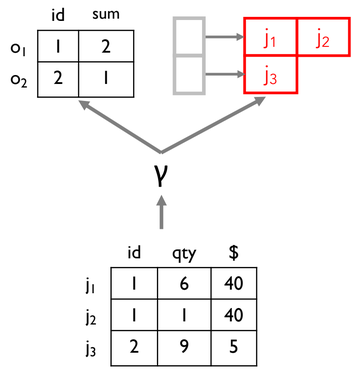
Defer

Doesn't block the query
Defers capture after operator



Inject

Faster overall but blocks query execution

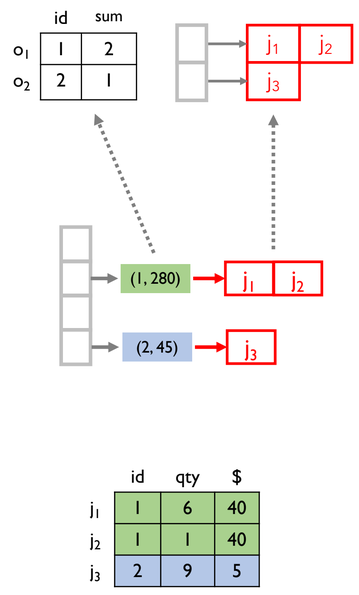


Example

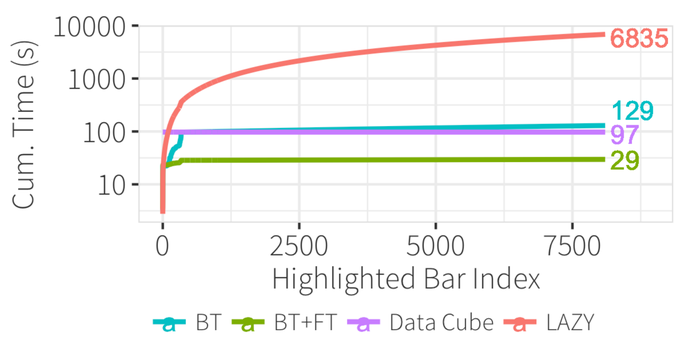
γ_{agg}
Generate results

γ_{build}
Build hash table

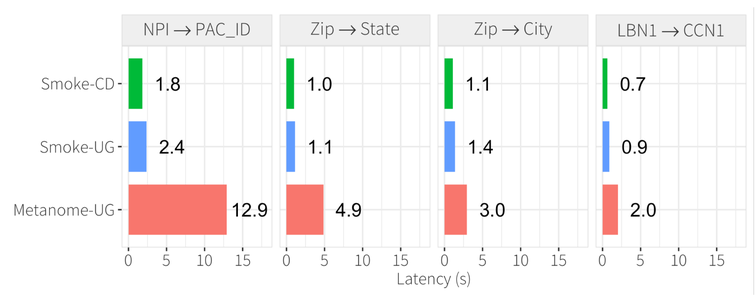
Input relation



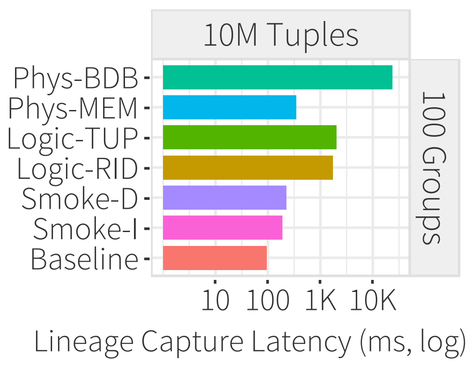
Crossfilter Performance



Profiling Performance



Capture Overhead (Group-By)



Conclusion

Lineage capture can be

- Fast enough to be interactive
- Competitive with hand-written implementations
- Useful for data-intensive interactive apps

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[SIGMOD18] A Deep breath of Data-Intensive Lineage Applications
[HILDA18] Provenance for Interactive Visualizations
[CIDR17] Combining Design and Performance in a DVMS