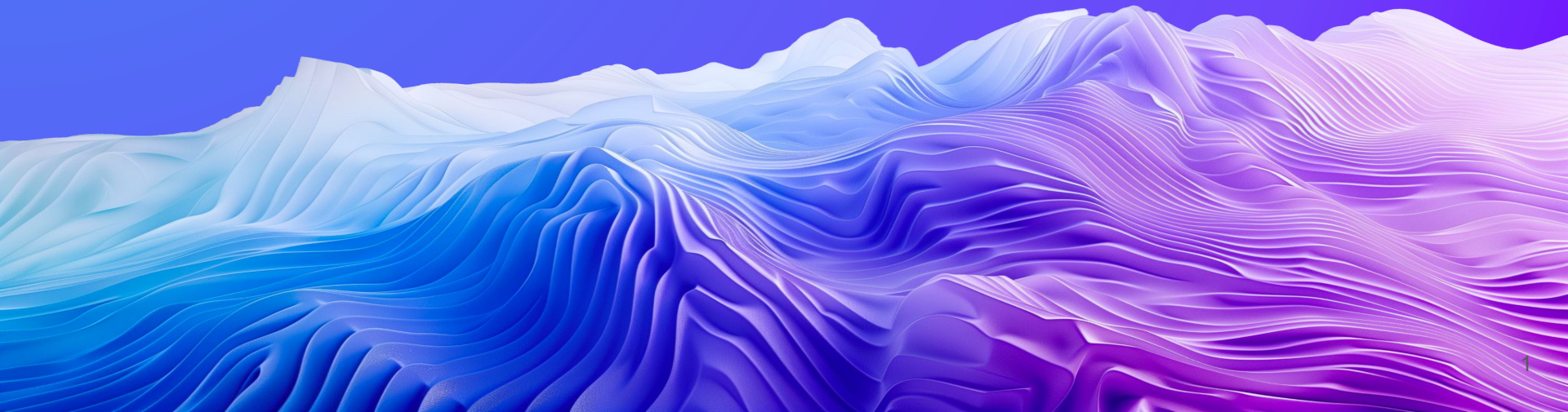
SCARF

Scarf & ClickHouse

December 12, 2024



Background

About me

- Founder & CEO of **Scarf**
- Based in Oakland, CA
- OSS maintainer, entrepreneur
- Board @ Haskell Foundation
- Former engineer @ Pandora

About Scarf

- 5-year-old startup
- 15 people
- Download metrics with artifact registry gateway, package telemetry, and web pixels.
- Works with both commercial and non-commercial open source projects
- Promote OSS sustainability and businesses with responsible but powerful anonymized usage analytics

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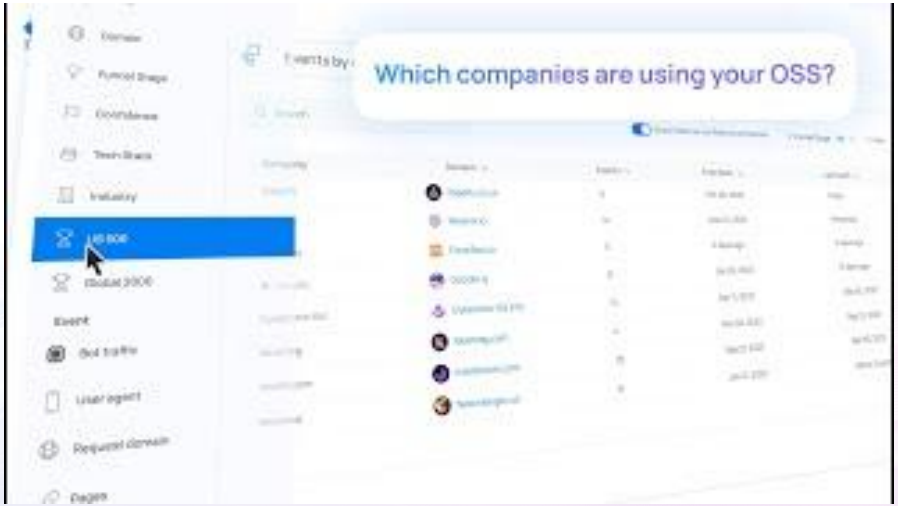
The product

Open source usage analytics for sales & marketing intelligence.

We process over 1B OSS downloads and events each month through our gateway.



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Before Clickhouse

Stage 0: All OSS downloads went to a raw `package_events` table in PostgreSQL.

public.package_events	[BASE TABLE]
id [integer]	
user__id [integer]	
package_release__uuid [text]	
event_type [text]	
created_at [timestamp with time zone]	
raw_platform [text]	
raw_arch [text]	
mac [text]	
ip_address [text]	
dependent_package_name [text]	
dependent_package_version [text]	
dependent_package__uuid [text]	
dependent_package_release__uuid [text]	
package__uuid [text]	
ip_lookups__id [integer]	
package_name [text]	
package_release_version [text]	
scarf_version [text]	
dependent_package_name_hash [text]	
dependent_package_version_hash [text]	
entity__id [integer]	

Stage 1: Known set of aggregations are pre-computed and kept up to date

public.aggregates	[BASE TABLE]
id [bigint]	
package__uuid [text]	
aggregation_type [smallint]	
grouping_key_1 [text]	
count [bigint]	
date_ [date]	
unique_count [hll]	
grouping_key_2 [text]	
rollup [character(1)]	
version [smallint]	
artifact__uuid [uuid]	
flags [smallint]	
confidence [double precision]	
company__id [integer]	

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What problem were we solving for

- Query flexibility
  - Needed a solution that supported real-time ad-hoc queries without re-engineering the database.
  - Aggregations in psql were lossy and limit analytics across various columns
- Scalability challenges
  - The existing PostgreSQL system aggregated data into rollups that was rigid and preventing us from creating new data views quickly.
  - Serving raw events directly out of psql was far too slow for customers with >10M events / month
- Cost
  - Aggregations were difficult to maintain
  - Adding new aggregations meant expensive reprocessing jobs

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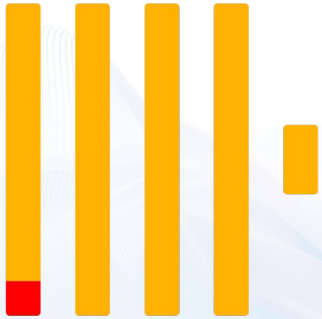

ClickHouse

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A mega `events` table in ClickHouse

events	[ReplicatedReplacingMergeTree]
endpoint_confidence	[Decimal(9, 3)]
package_version	[String]
entity_id	[UInt64]
entity_name	[String]
package_id	[LowCardinality(UUID)]
package_name	[String]
tracking_pixel_id	[LowCardinality(UUID)]
tracking_pixel_name	[String]
tracking_pixel_referer	[String]
tracking_pixel_referer_domain	[String]
tracking_pixel_referer_query	[Array(Tuple(String, String))]
docker_image	[String]
docker_reference	[String]
docker_backend_registry	[String]
python_version	[String]
python_file_name	[String]
python_redirect_url	[String]
scarfjs_version	[String]
scarfjs_architecture	[String]
scarfjs_platform	[String]
file_variables	[Map(String, String)]
user_imported_version	[String]
dnt	[Bool]
is_bot	[Nullable(Bool)]
platform	[String]
client_name	[String]
client_version	[String]
request_id	[String]
request_method	[LowCardinality(String)]
request_host	[String]
time	[DateTime('UTC')]
request_query	[String]
request_remote_address	[String]
response_status	[UInt16]
origin_id	[UUID]
endpoint_id	[String]
endpoint_provenance	[String]
endpoint_type	[LowCardinality(String)]
endpoint_domain	[String]
endpoint_name	[String]
endpoint_geo_country	[String]
endpoint_geo_state	[String]
endpoint_geo_city	[String]
endpoint_geo_postal_code	[String]
endpoint_geo_latitude	[Float64]
endpoint_geo_longitude	[Float64]
endpoint_company_id	[UInt64]
importance	[LowCardinality(String)]
points	[UInt64]
os	[String]
request_user_agent	[String]
revision	[UInt8]
event_type	[Enum8('unknown' = 1, 'manifest-fetch' = 2, 'pixel-fetch' = 3, 'install' = 4, 'file-download' = 5, 'python-package-download' = 6, 'user-imported' = 7)]
user_imported_event_type	[String]
inserted_at	[DateTime('UTC')]
appraisal_type	[LowCardinality(String)]
appraisal_created_by_user	[Int32]
event_provenance	[LowCardinality(String)]
appraisal_id	[Int64]
appraisal_updated_at	[DateTime('UTC')]
artifact_id	[LowCardinality(UUID)]
artifact_type	[LowCardinality(String)]

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What we got from ClickHouse

- **Most importantly, we can give our customers impressive real-time filtering capabilities!**
- De-duplication of events for free!
- Query speed
- Real-time and traditional OLAP all in one database
  - Real-time: Queries powering interactive dashboards for customers
  - Traditional: Custom reports and BI
- Large library of useful SQL functions
  - There is a simple function available to answer most analytical questions and powerful variants
  - Existing reporting and analytics tools can connect directly
- System tables are fantastic for debugging and answering questions about our database and queries

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Our workload

Query volume

- Peak activity
  - ~100 queries per second (QPS)
- Daily Reads
  - Average 1 Read QPS
  - ~100,000 Reads per day

Write volume

- Average
  - 0.7 Write QPS
  - ~60,000 Writes per day
- Event Appends
  - ~50M new events OR ~25 GiB/day
- Batch Inserts
  - Using **async_insert** to batch 500 - 1,500 events at a time
  - Batches are flushed every 2 seconds on average

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Our cluster

- Nodes: 2 (1 shard, 2 replicas)
- Node Type: m6i.4xlarge
- Node Storage: 10 TiB
- Node Memory: 64 GB
- Node CPU: 16

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Issues we had to solve for

- There was no mature Haskell client, so we wrote one. Will be open sourced soon.
- Large Aggregations with poor index fit failing due to OOM errors
- Query performance using `OR` → rewrite as `IN()`
- Deduplication in Clickhouse was magical but also confusing: When to use `FINAL` on a query vs when to trust the eventual `OPTIMIZE`?

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Open problems

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Operational overhead of index changes

Each table gets a single PRIMARY KEY and ORDER BY key.

In most cases, the only way to change these is a multi-step of creating a new table with desired index, copying over data from previous table, swapping the new table in for the previous table, and backfill any data that got missed in the transition.

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Pre-Aggregation vs Dynamic Filtering

CH is fast enough to serve interactive dashboards to small - medium customers backed by various aggregations and filterings **on columns outside of the index**.

This doesn't scale well to our large customers. CH has great support for pre-aggregation with Materialized Views, but we'd lose:

1) dynamic filtering (filters need to be applied before aggregation for this to work)
2) upstream deduplicating of ReplacingMergeTree

Refreshable Materialized Views may solve (2)

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ReplacingMergeTree ties deduplication to disk ordering

- With `ReplacingMergeTree`, the ORDER BY is what's used to deduplicate tables and determine the order data is laid out on disk. **The unique fields that we'd like to deduplicate our tables on are different from the ones we want in our queries.**
  - We settle for including both in our ORDER BY index, with the queryable columns first and the unique key last
- Some work was done on a `UniqueMergeTree` table engine with a `UNIQUE KEY` table property that is separate from the table's `ORDER BY`.

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Thank you!

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