



# Serving 5m analytics queries a month, with Clickhouse!



Tim Glaser  
Co-founder/CTO



---

# Three parts

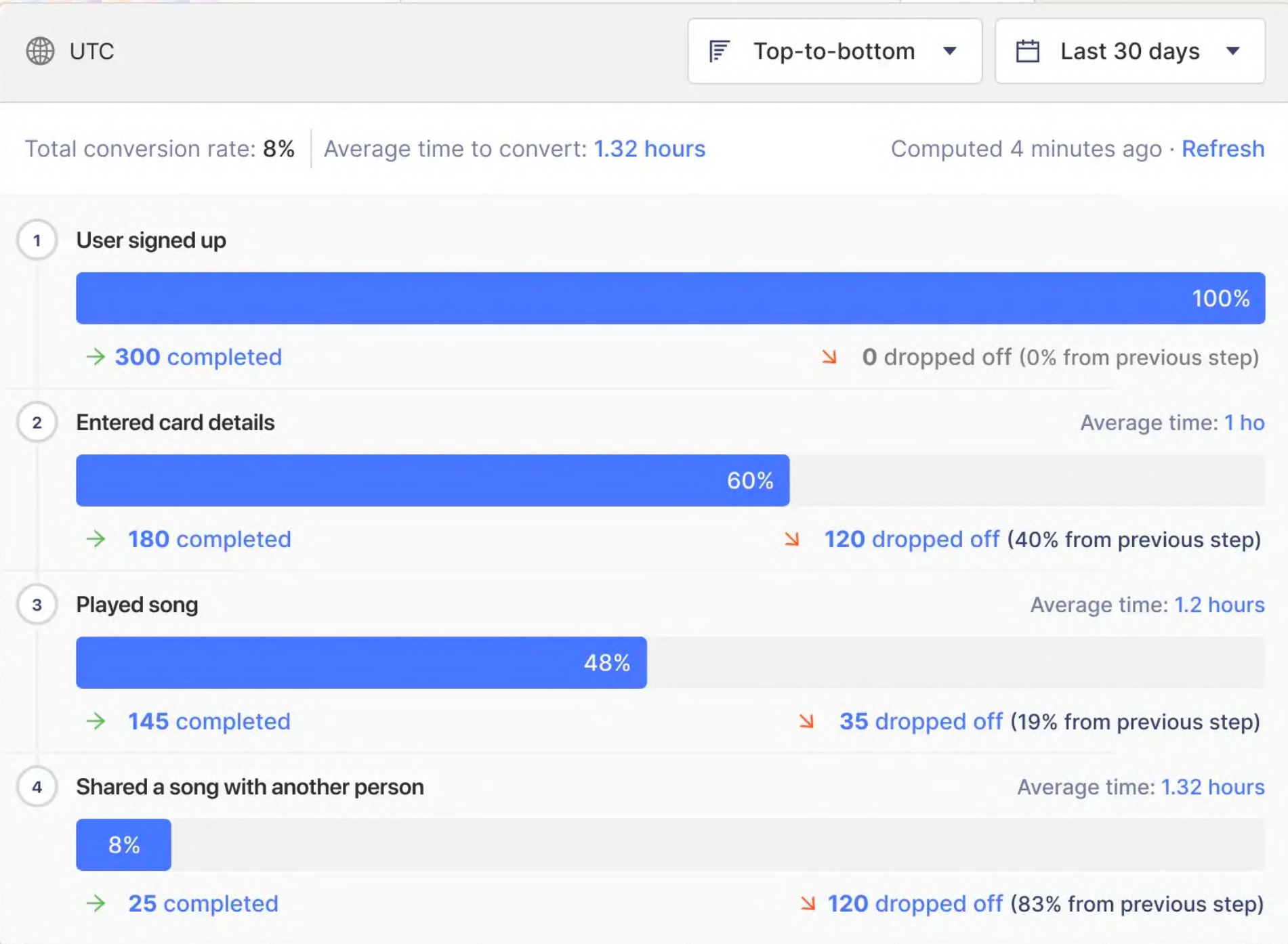
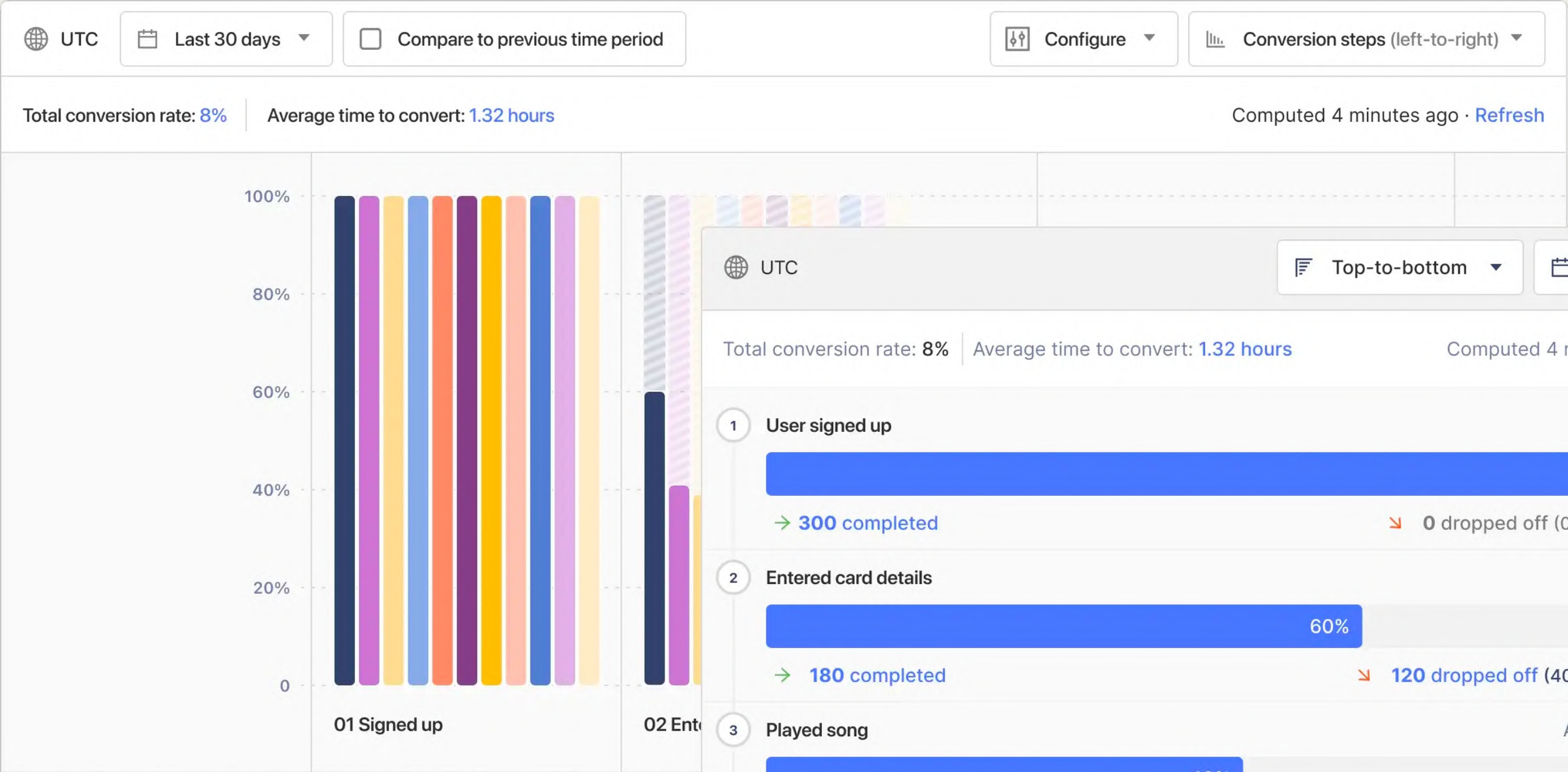
**What is PostHog**

---

**How we scaled to millions of queries/day**

---

**Launching HouseWatch**



Series

A

Pageview

Unique users

1

where

Current URL

= equals

https://www.isgoogleanalyticsillegal.com/

X

X

AND

Add filter

+ Add graph series

Enable formula mode

Filters

Filter out internal and test users

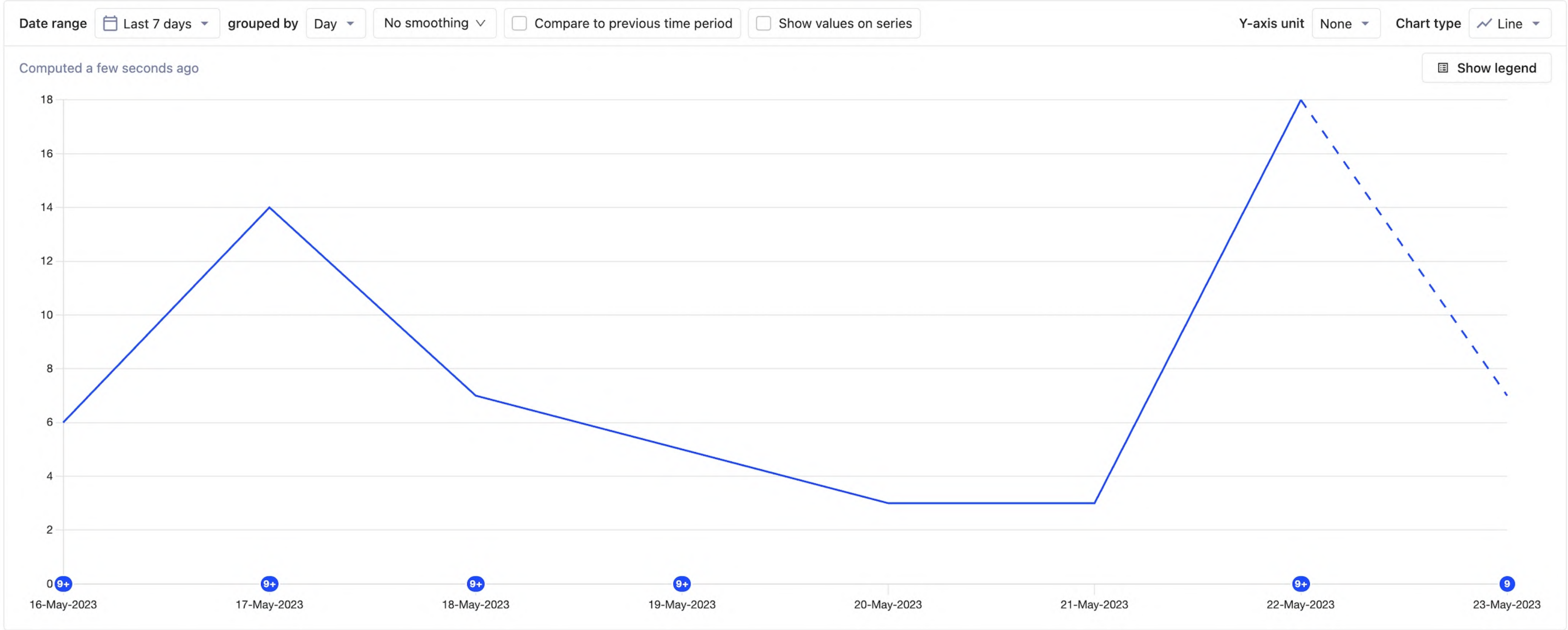
+ Add filter group

Breakdown by

+ Add breakdown

Sampling

BETA







U user@hogflix.com

Today at 11:04am · Firefox · Oregon, United States · Resolution: 1280 × 720 (72.8%)

HOGFLIX

Home Hogumentaries For the Hoglets Pay Per Hog

## Hogflix Originals

It's a  
Hard  
Hog Life  
for Us



THE HOG  
WHO CRIED  
WOLF



2022:  
hogs in space



Hogs  
who  
Hike



Search for events



PAGEVIEW 00:00:01  
http://hogflix.com

AUTOCAPTURE 00:00:58  
Clicked "Schedule demo"

EVENT 00:01:36  
Calendar event scheduled

PAGELEAVE 00:01:41  
http://hogflix.com/demo

PAGEVIEW 00:02:01  
http://hogflix.com/login

EVENT 00:02:31  
Sign in

VERIFIED EVENT 00:03:11  
Rageclick

VERIFIED EVENT 00:03:11  
Rageclick

00:17:23 / 00:34:46

Playback speed 1x Skip inactivity

# Release conditions

**Set 1** Match users against **all** criteria

↳ email equals joe@posthog.com luke@posthog.com

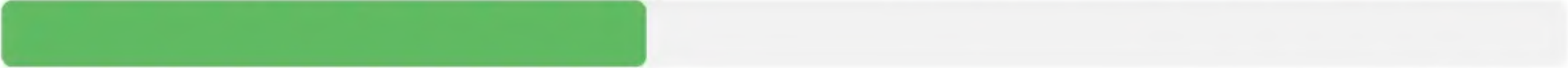
& Cohort Feature Flag Creators (Static)

Rolled out to 100% of users in this set.



Experiment progress

Computed a few seconds ago · [Refresh](#)



200 participants seen Goal: 500 participants

Variant results

Test Group 1 ✔ Top result · [Release to production](#)



Probability that this variant is the best: **65.7%**

Test Group 3



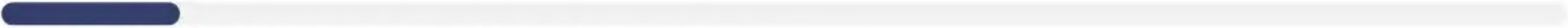
Probability that this variant is the best: **11.4%**

Test Group 2































Probability that this variant is the best: **11.4%**

Control Group

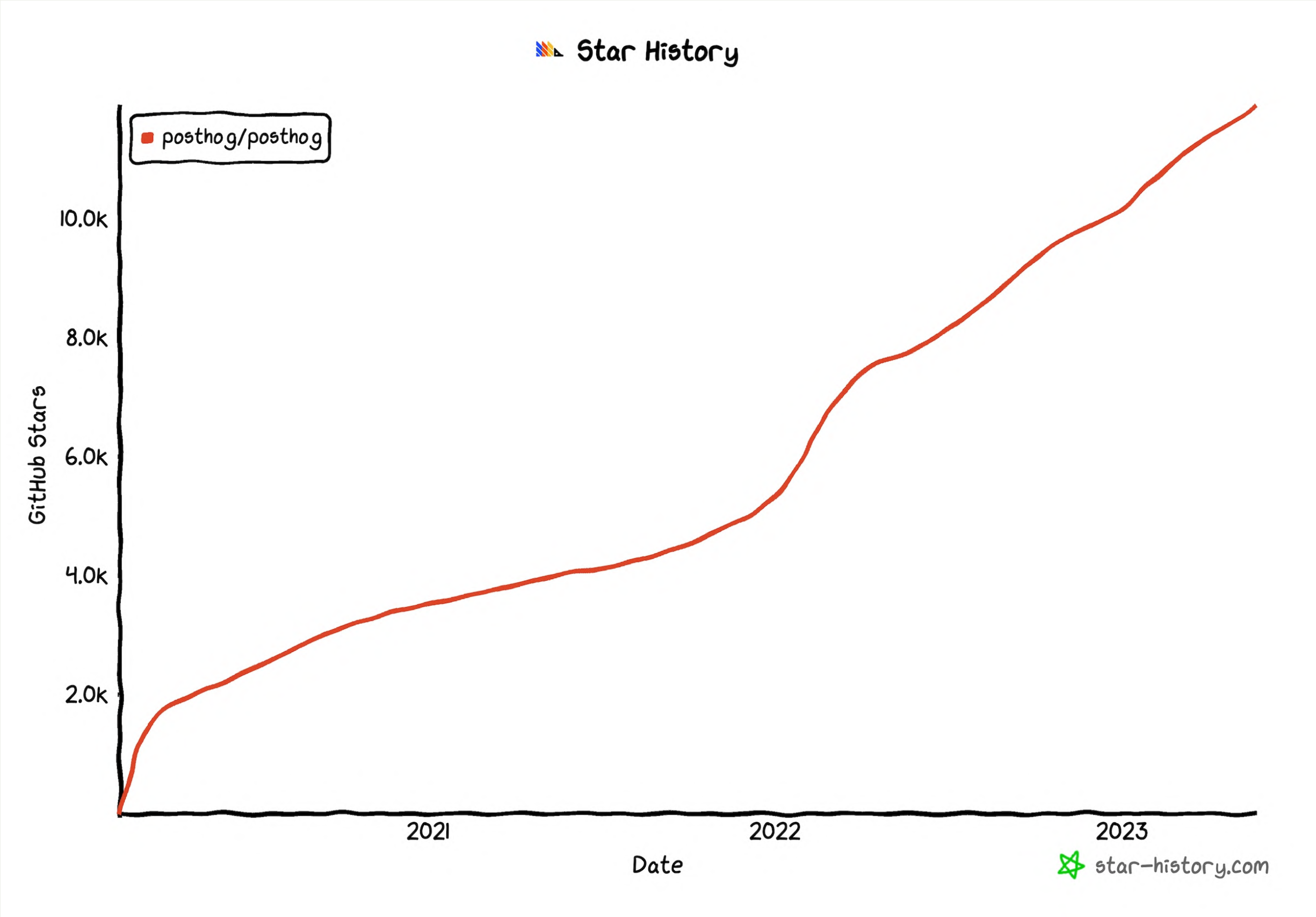


Probability that this variant is the best: **11.4%**

RECOMMENDED RUNNING TIME	RECOMMENDED SAMPLE SIZE
~29.7 days	~500 persons
ELAPSED RUN TIME	PARTICIPANT COUNT
5 days	200 persons
CONVERSION GOAL	
1 Pageview	
↳ Where Current URL equals http://hogflix.com	
2 Viewed pricing	
3 Signed up	
↳ Where Browser equals Firefox	
and Current URL equals /signup?param=123	
FILTERS	
↳ Where Current URL equals http://hogflix.com	
and Current URL equals http://hogflix.com	
and Current URL equals http://hogflix.com	
SECONDARY METRICS	
● Control ● Test 1 ● Test 2	
Subscription started (count)	52 62 61

 Airbyte Exporter	FREE	 Avo Inspector	FREE	 BigQuery Export	FREE	 Customer.io Connector	FREE
 Databricks Export	FREE	 Engage Connector	FREE	 Google Cloud Storage Export	FREE	 Google Pub/Sub Connector	FREE
 Hubspot Connector	FREE	 Ingestion Alert	FREE	 Intercom Connector	FREE	 Laudspeaker Connector	FREE
 Memphis Exporter	FREE	 Outfunnel Exporter	FREE	 Pace Integration	FREE	 PagerDuty Connector	FREE
 Patterns Connector	FREE	 PostgreSQL Export	FREE	 Redshift Export	FREE	 PostHog Replicator	FREE
 RudderStack Export	FREE	 Amazon S3 Export	FREE	 Salesforce Connector	FREE	 Sendgrid Connector	FREE
 Sentry Connector	FREE	 Snowflake Export	FREE	 Twilio Connector	FREE	 Variance Connector	FREE







81k+

Developer community

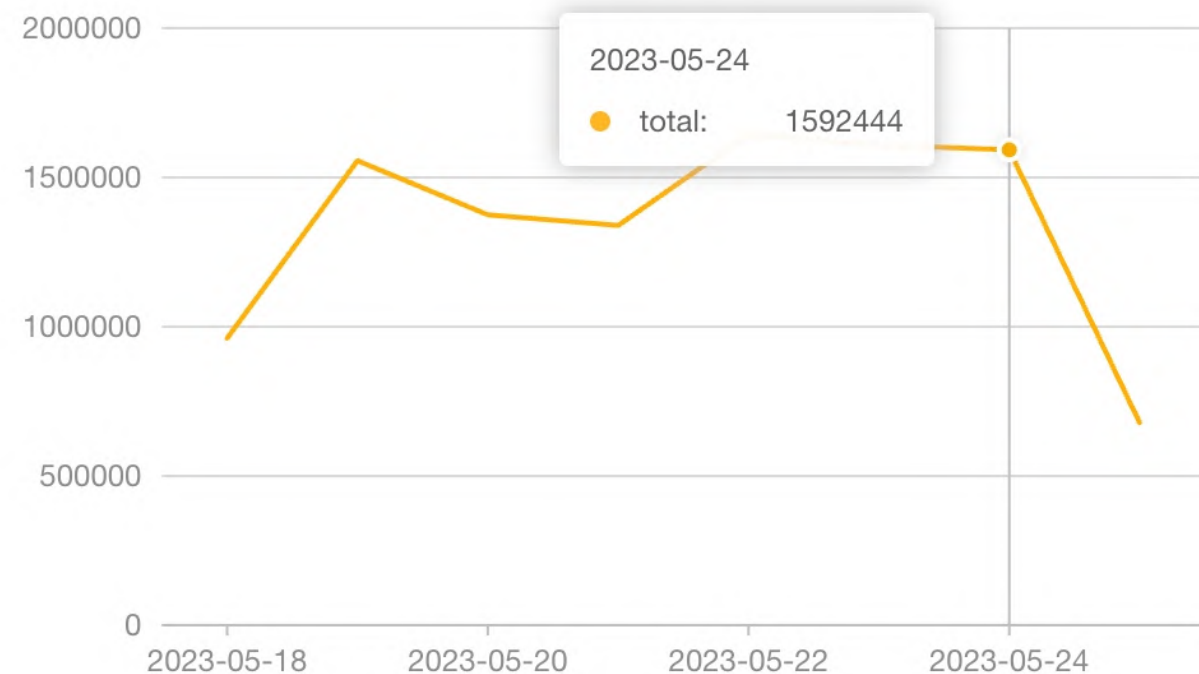
411+

Contributors

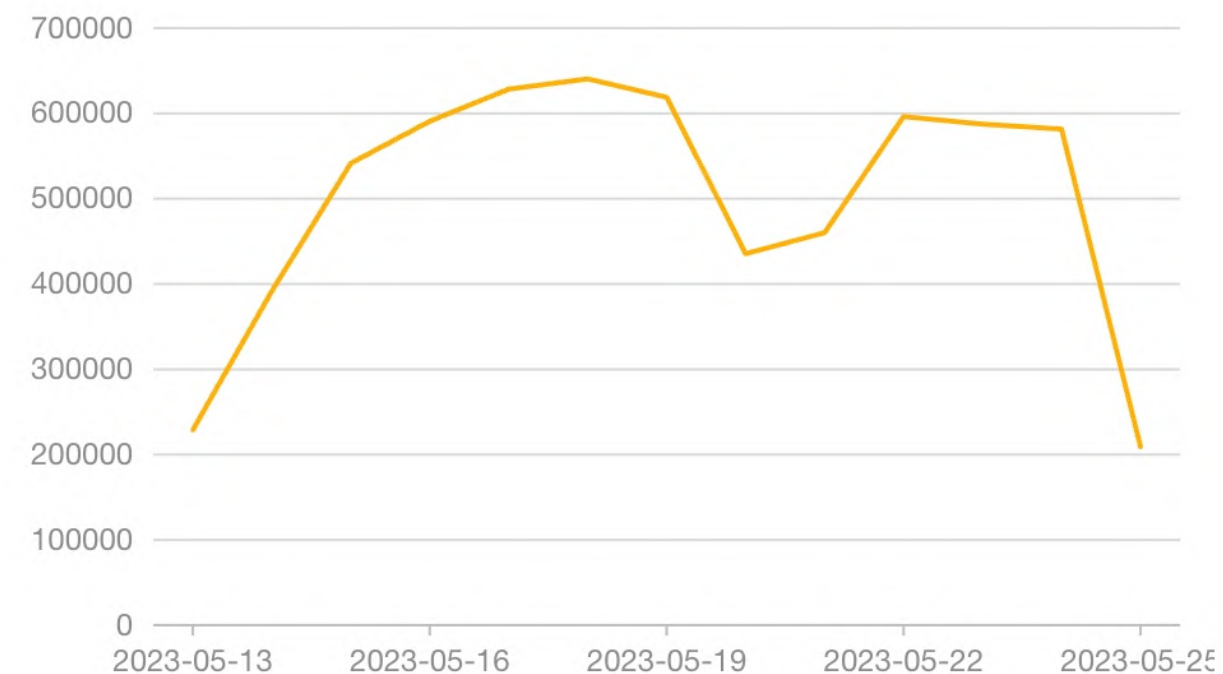
50b+

Events tracked

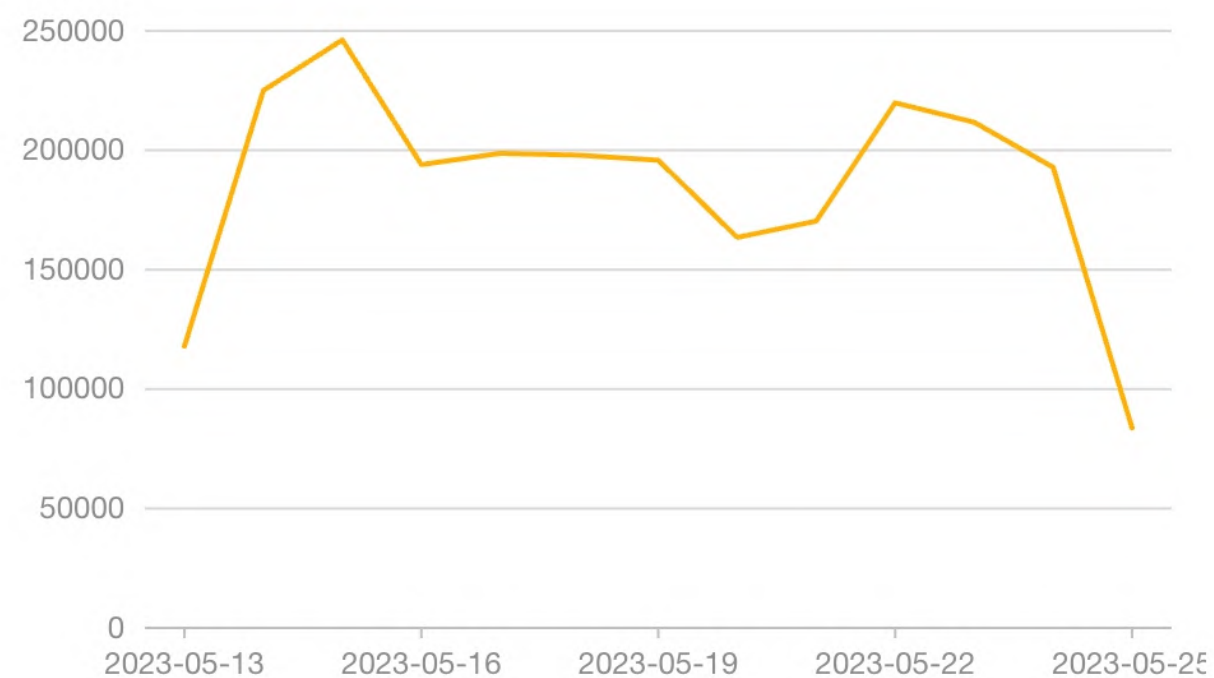
Number of queries



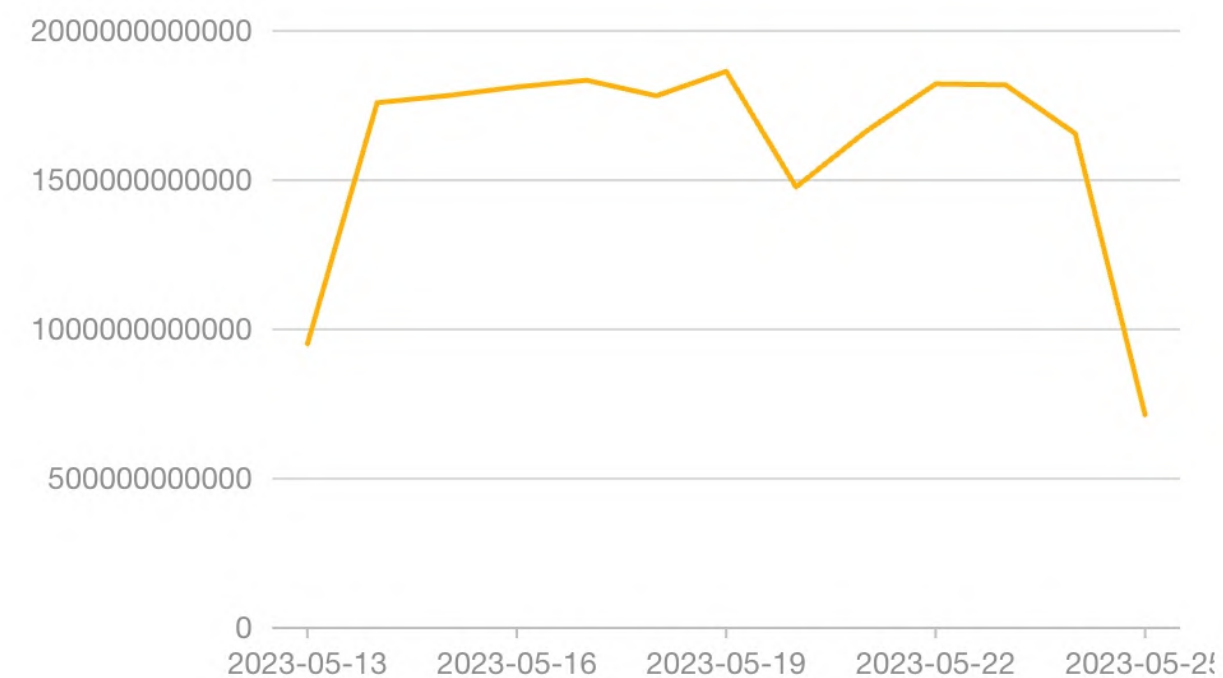
Data read (GB)



Memory usage (GB)



CPU usage (seconds) ⓘ

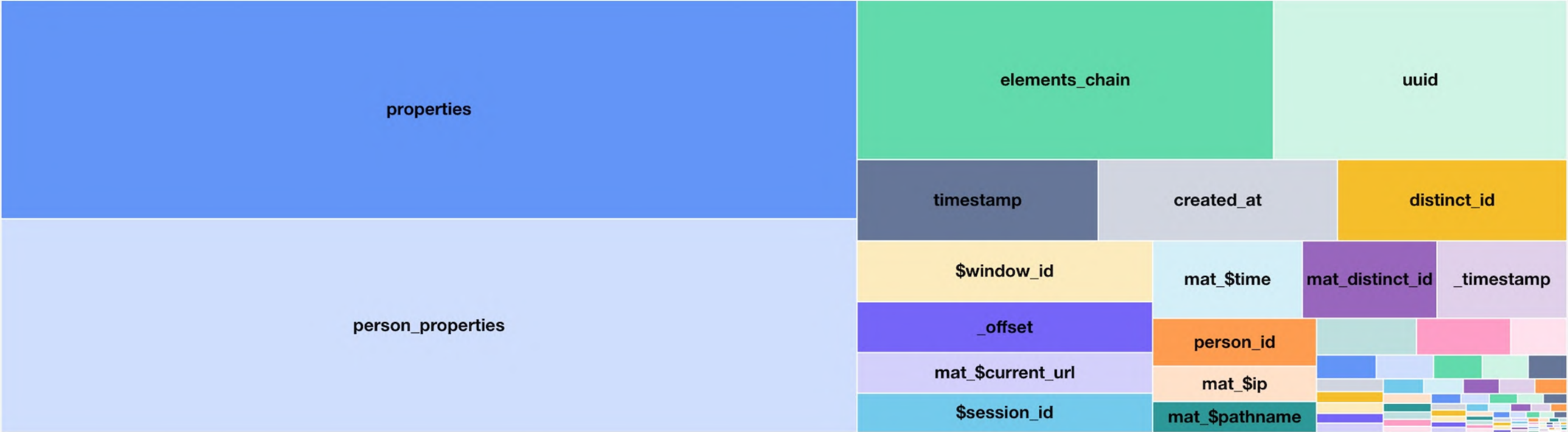




# Table: sharded\_events

Columns

Parts



properties person\_properties elements\_chain uuid timestamp created\_at distinct\_id \$window\_id \_offset mat\_\$current\_url \$session\_id 1/11

Name	type	Compressed	Uncompressed
properties	String	1.89 TiB	62.04 TiB
person_properties	String	1.85 TiB	47.92 TiB
elements_chain	String	687.33 GiB	8.54 TiB
uuid	UUID	484.44 GiB	503.71 GiB
timestamp	DateTime64(6, 'UTC')	203.13 GiB	251.86 GiB
created_at	DateTime64(6, 'UTC')	201.30 GiB	251.86 GiB

# Server sizing

Instance Size	vCPU	Memory (GiB)	Instance Storage (GB)	Network Bandwidth (Gbps)***	EBS Bandwidth (Gbps)
r6i.large	2	16	EBS-Only	Up to 12.5	Up to 10
r6i.xlarge	4	32	EBS-Only	Up to 12.5	Up to 10
r6i.2xlarge	8	64	EBS-Only	Up to 12.5	Up to 10
r6i.4xlarge	16	128	EBS-Only	Up to 12.5	Up to 10
r6i.8xlarge	32	256	EBS-Only	12.5	10
r6i.12xlarge	48	384	EBS-Only	18.75	15
r6i.16xlarge	64	512	EBS-Only	25	20
r6i.24xlarge	96	768	EBS-Only	37.5	30
r6i.32xlarge	128	1,024	EBS-Only	50	40
r6i.metal	128	1,024	EBS-Only	50	40
r6id.large	2	16	1x118 NVMe SSD	Up to 12.5	Up to 10
r6id.xlarge	4	32	1x237 NVMe SSD	Up to 12.5	Up to 10
r6id.2xlarge	8	64	1x474 NVMe SSD	Up to 12.5	Up to 10
r6id.4xlarge	16	128	1x950 NVMe SSD	Up to 12.5	Up to 10
r6id.8xlarge	32	256	1x1900 NVMe SSD	12.5	10
r6id.12xlarge	48	384	2x1425 NVMe SSD	18.75	15
r6id.16xlarge	64	512	2x1900 NVMe SSD	25	20
r6id.24xlarge	96	768	4x1425 NVMe SSD	37.5	30
r6id.32xlarge	128	1,024	4x1900 NVMe SSD	50	40
r6id.metal	128	1,024	4x1900 NVMe SSD	50	40

## Storage Optimized

Storage optimized instances are designed for workloads that require high, sequential read and write access to very large data sets on local storage. They are optimized to deliver tens of thousands of low-latency, random I/O operations per second (IOPS) to applications.

I3	I3en	D2	D3	D3en	H1
<p>This <a href="#">instance family</a> provides dense Non-Volatile Memory Express (NVMe) SSD instance storage optimized for low latency, high random I/O performance, high sequential disk throughput, and offers the lowest price per GB of SSD instance storage on Amazon EC2. I3en also offers Bare Metal instances (i3en.metal), powered by the Nitro System, for non-virtualized workloads, workloads that benefit from access to physical resources, or workloads that may have license restrictions.</p> <p><b>Features:</b></p> <ul style="list-style-type: none"><li>Up to 60 TB of NVMe SSD instance storage</li><li>Up to 100 Gbps of network bandwidth using Elastic Network Adapter (ENA)-based Enhanced Networking</li><li>High random I/O performance and high sequential disk throughput</li><li>Up to 3.1 GHz Intel® Xeon® Scalable (Skylake) processors with new Intel Advanced Vector Extension (AVX-512) instruction set</li><li>Powered by the <a href="#">AWS Nitro System</a>, a combination of dedicated hardware and lightweight hypervisor</li><li>Support bare metal instance size for workloads that benefit from direct access to physical processor and memory</li><li>Support for <a href="#">Elastic Fabric Adapter</a> on i3en.24xlarge</li></ul>					
Instance	vCPU	Mem (GiB)	Local Storage (GB)	Network Bandwidth	
i3en.large	2	16	1 x 1,250 NVMe SSD	Up to 25 Gbps	
i3en.xlarge	4	32	1 x 2,500 NVMe SSD	Up to 25 Gbps	
i3en.2xlarge	8	64	2 x 2,500 NVMe SSD	Up to 25 Gbps	
i3en.3xlarge	12	96	1 x 7,500 NVMe SSD	Up to 25 Gbps	
i3en.6xlarge	24	192	2 x 7,500 NVMe SSD	25 Gbps	
i3en.12xlarge	48	384	4 x 7,500 NVMe SSD	50 Gbps	
i3en.24xlarge	96	768	8 x 7,500 NVMe SSD	100 Gbps	
i3en.metal	96	768	8 x 7,500 NVMe SSD	100 Gbps	

All instances have the following specs:

- 3.1 GHz all core turbo Intel® Xeon® Scalable (Skylake) processors
- Intel AVX†, Intel AVX2†, Intel AVX-512†, Intel Turbo
- EBS Optimized
- Enhanced Networking



PropertiesJSON

🔍

Search for property k...

☐ Hide PostHog properties

📄 Timestamp	2023-05-25T13:03:17.290Z	DATETIME	📄
📄 OS	Mac OS X	STRING	📄
📄 OS Version	10.15.7	STRING	📄
📄 Browser	Chrome	STRING	📄
📄 Device Type	Desktop	STRING	📄
📄 Current URL	https://app.posthog.com/	🔗 STRING	📄
📄 Host	app.posthog.com	STRING	📄
📄 Path Name	/	STRING	📄
📄 Browser Version	113	NUMERIC	📄
📄 Browser Language	en-GB	STRING	📄
📄 Screen Height	1890	NUMERIC	📄
📄 Screen Width	3360	NUMERIC	📄
📄 Viewport Height	1984	NUMERIC	📄
📄 Viewport Width	1866	NUMERIC	📄



Series

A

Pageview

Unique users

1

where

Current URL

= equals

https://www.isgoogleanalyticsillegal.com/

X

X

AND

Add filter

+ Add graph series

Filters

Filter out internal and test users

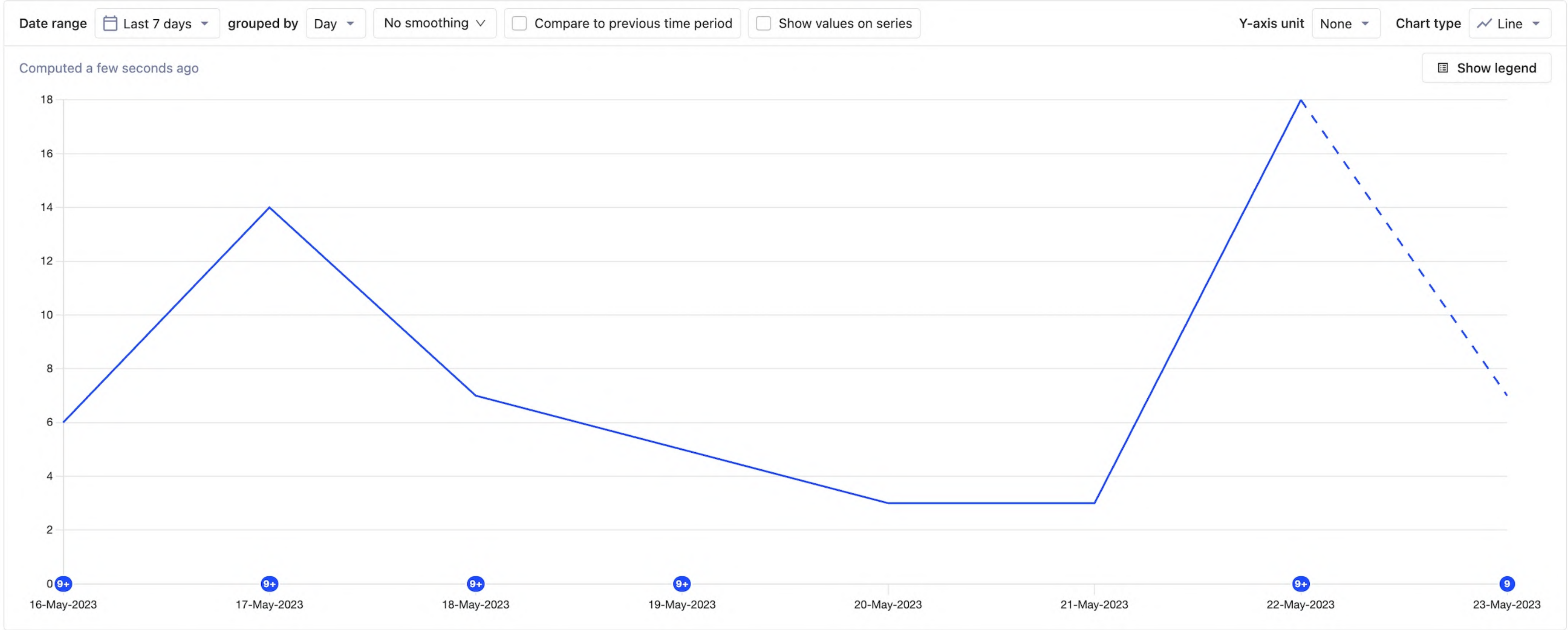
+ Add filter group

Breakdown by

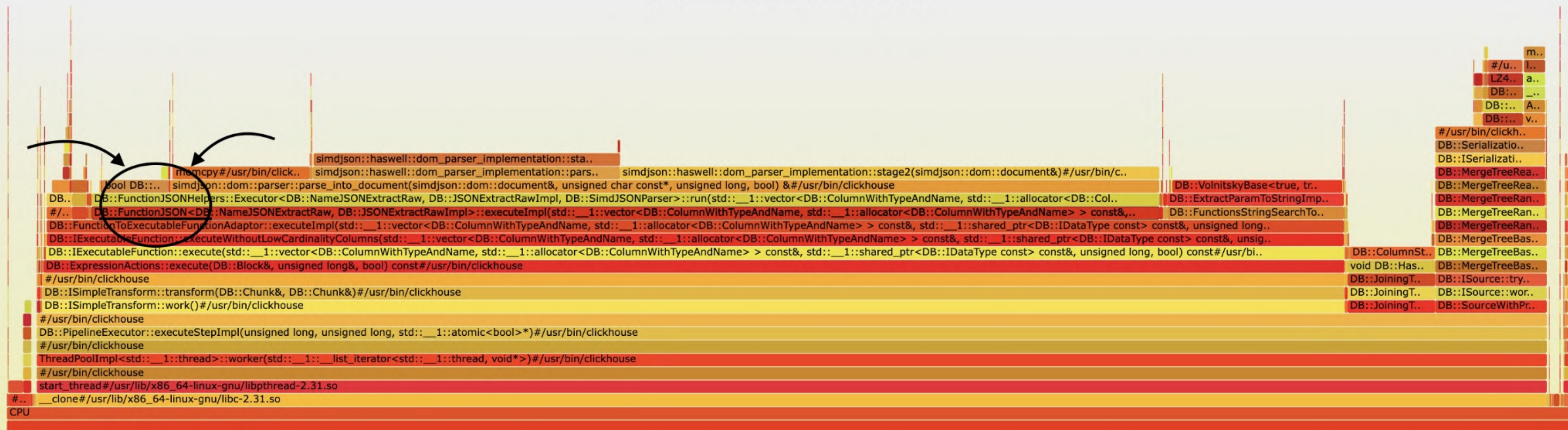
+ Add breakdown

Sampling

BETA



### Query with JSONExtractString flamegraph





```
ALTER TABLE events  
ADD COLUMN mat_$current_url  
VARCHAR MATERIALIZED JSONExtractString(properties_json, '$current_url')
```



Series

A

Pageview

Unique users

1

where

Current URL

= equals

https://www.isgoogleanalyticsillegal.com/

X

X

AND

Add filter

+ Add graph series

Filters

Filter out internal and test users

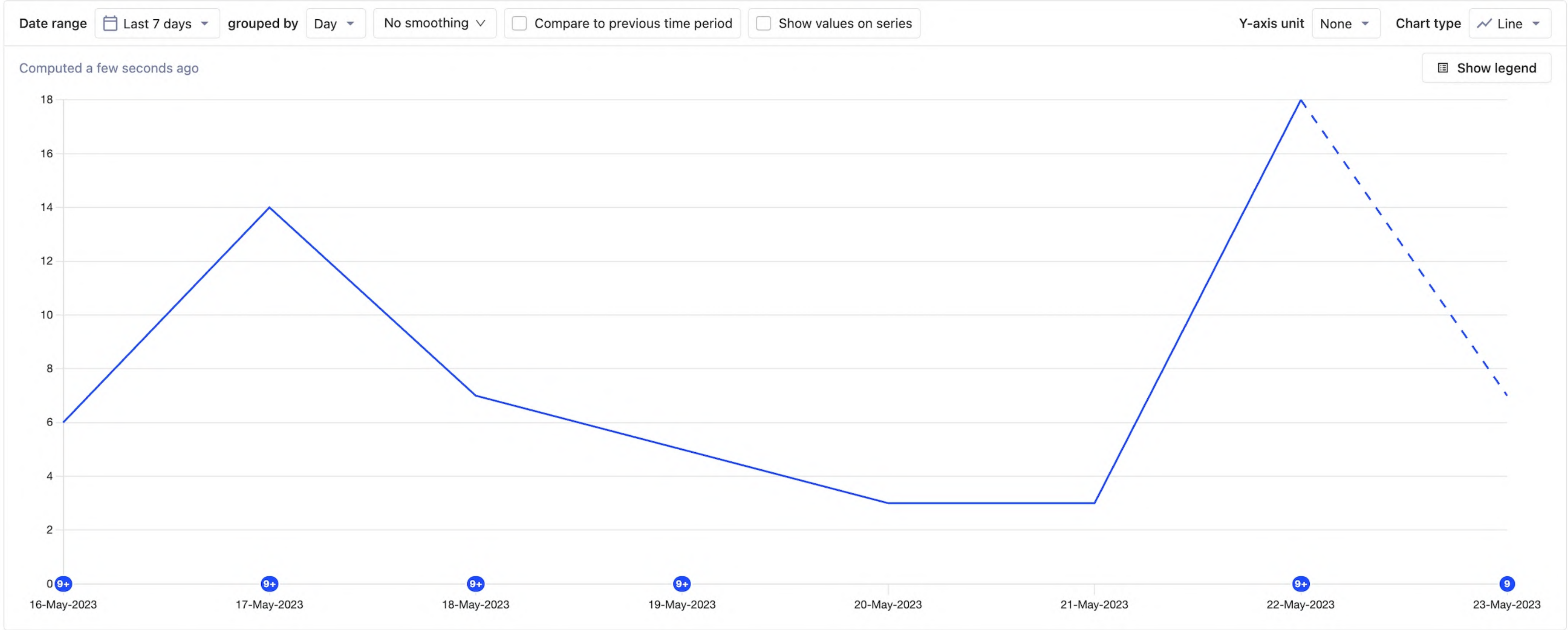
+ Add filter group

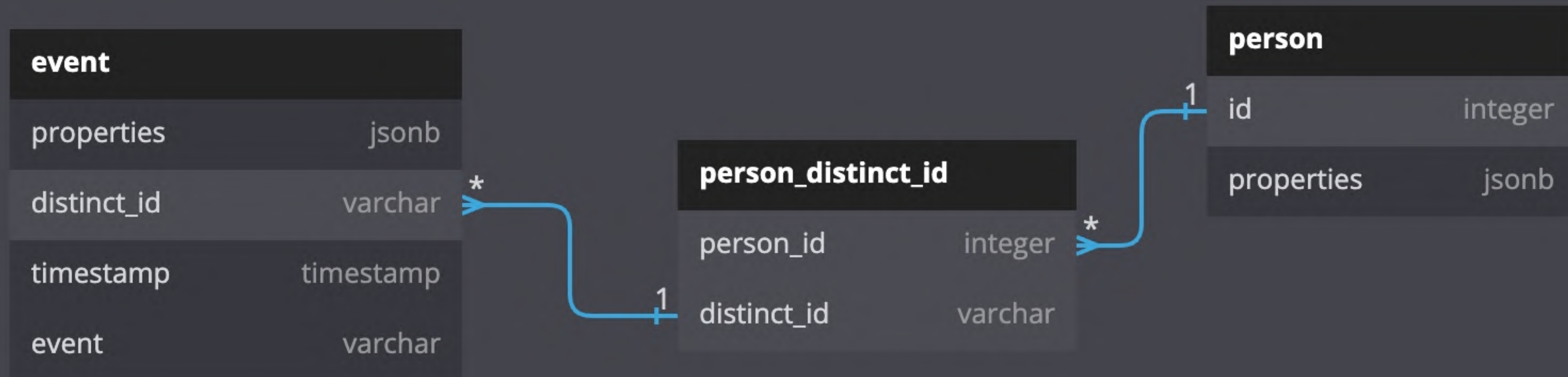
Breakdown by

+ Add breakdown

Sampling

BETA







```
1  SELECT
2      count(DISTINCT pdi.person_id) AS total,
3      toStartOfDay(timestamp) AS date
4  FROM
5      events e
6      INNER JOIN (
7          SELECT distinct_id, argMax(person_id, version) as person_id
8          FROM person_distinct_id2
9          GROUP BY distinct_id
10         HAVING argMax(is_deleted, version) = 0
11     ) AS pdi
12     ON e.distinct_id = pdi.distinct_id
13 WHERE
14     event = '$pageview'
```





## event

properties	jsonb
------------	-------

distinct_id	varchar
-------------	---------

timestamp	timestamp
-----------	-----------

event	varchar
-------	---------

person_id	varchar
-----------	---------

person_properties	jsonb
-------------------	-------



## person\_overrides

old_person_id	integer
---------------	---------

override_person_id	integer
--------------------	---------

version	integer
---------	---------

```
1 SELECT
2     count(
3         DISTINCT if(
4             notEmpty(overrides.person_id),
5             overrides.person_id,
6             e.person_id
7         )
8     ) AS total,
9     toStartOfDay(timestamp) AS date
10 FROM
11     events e
12     LEFT OUTER JOIN (
13         SELECT
14             argMax(override_person_id, version) as person_id,
15             old_person_id
16         FROM
17             person_overrides
18         GROUP BY
19             old_person_id
20     ) AS overrides ON e.person_id = overrides.old_person_id
21 WHERE
22     event = '$pageview'
```



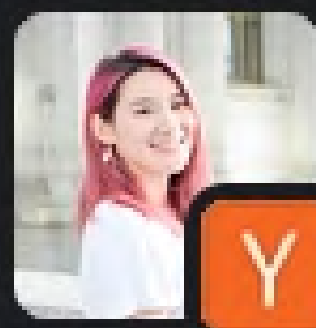


#← Also sent to the channel



**Yakko Majuri** 1 month ago

Not a lot of data yet on the new approach but from my initial digging seems we've taken your average query duration down from ~18s to ~1s and p95 to ~4s from ~60s.



**cat** 1 month ago



oh nice!! yeah I can edit graphs again 😊



1





```
SQUASH_EVENTS_QUERY = """
```

```
ALTER TABLE
```

```
    {database}.sharded_events
```

```
UPDATE
```

```
    person_id = dictGet('{database}.{dictionary_name}', 'override_person_id', (toInt32(team_id), person_id))
```

```
IN PARTITION
```

```
    %(partition_id)s
```

```
WHERE
```

```
    dictHas('{database}.{dictionary_name}', (toInt32(team_id), person_id))
```

```
    {team_id_filter}
```

```
    AND created_at <= %(latest_created_at)s;
```

```
"""
```



Your query is taking a long time to complete. **We're still working on it.**

See below some options to speed things up.

[Click here to speed up calculation with 10% sampling](#)

In order to improve the performance of the query, you can also try to reduce the date range of your query, remove breakdowns, or get in touch with us by [submitting a bug report](#).

Query ID: ee21e4a4-47cf-45e5-a0cf-b99b41273661





Your query is taking a long time to complete. **We're still working on it.**

See below some options to speed things up.

[Click here to speed up calculation with 1% sampling](#)

In order to improve the performance of the query, you can also try to reduce the date range of your query, remove breakdowns, or get in touch with us by [submitting a bug report](#).

Query ID: 89e395ba-b8ac-4cad-afd3-354d052cd380



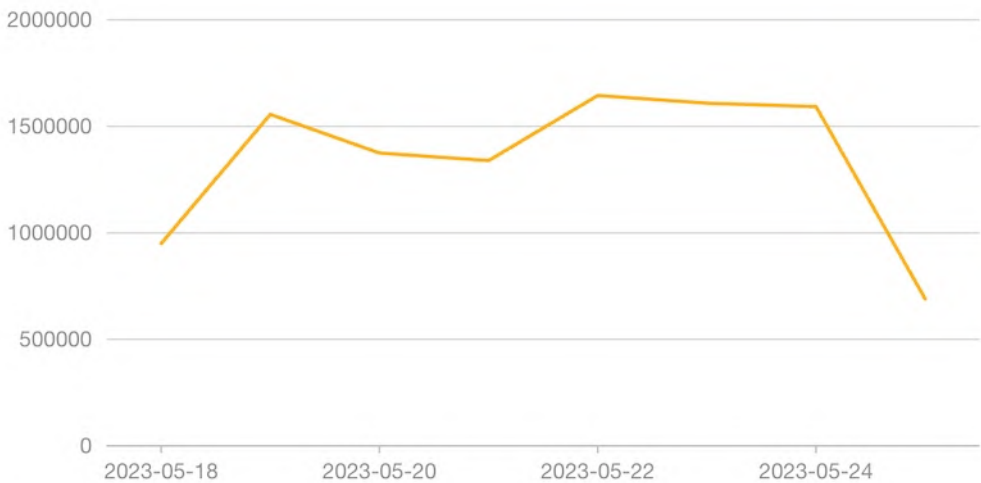
# Introducing HouseWatch

Overview

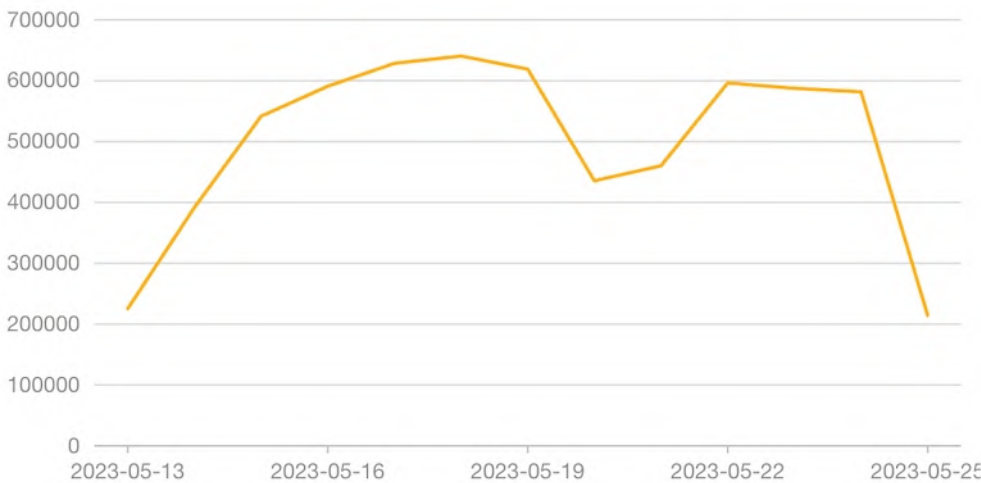
ClickHouse tip of the day

If you store JSON data in a VARCHAR column, consider materializing frequently accessed properties using materialized columns for much faster queries.

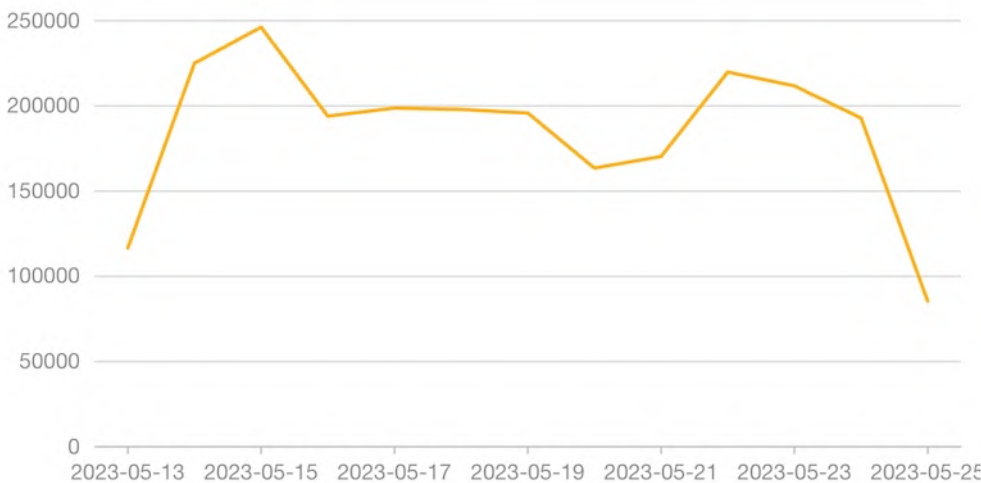
Number of queries



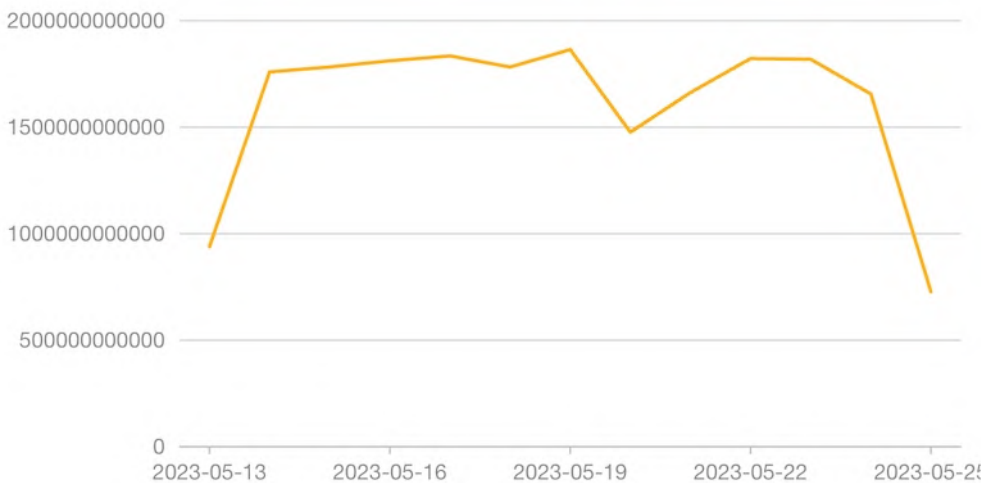
Data read (GB)



Memory usage (GB)



CPU usage (seconds) ⓘ







# Query performance

Click on queries to display more details.

Query	Avg time (ms)	Calls / min	% of all iops	% of runtime	Total iops
WITH step_runs AS ( SELECT ... FROM system.numbers LIMIT ifNull(bin_count, \$1) + \$2 ) fill USING (bin_from_seconds) ORDER BY bin_from_seconds	83302ms	0.012	1.5%	0.1%	51.59 TiB
SELECT ... FROM person_distinct_id2 WHERE team_id = \$1 GROUP BY distinct_id HAVING argMax(is_deleted, version) = \$2 ) AS pdi ON e.distinct_id = pdi.distinct_id WHERE team_id = \$3 AND event IN [\$4..] AND...	67510ms	0.001	0.5%	0.0%	16.16 TiB
SELECT ... FROM person_overrides WHERE team_id = \$1 GROUP BY old_person_id ) AS overrides ON e.person_id = overrides.old_person_id WHERE team_id = \$2 AND event = \$3 AND toTimeZone(timestamp, \$4)...	56684ms	0.001	0.2%	0.0%	6.29 TiB
WITH actor_query AS ( WITH \$1 as period, NULL as breakdown_values_filter, NULL as selected_interval, returning_event_query as ( SELECT ... FROM actor_query AS actor_activity GROUP BY breakdown_values,...	53109ms	0.001	0.2%	0.0%	7.00 TiB
SELECT ... FROM person_overrides WHERE team_id = \$1 GROUP BY old_person_id ) AS overrides ON e.person_id = overrides.old_person_id WHERE e.team_id = \$2 AND event = \$3 AND ((( NOT ("mat_pp_email"...	52134ms	0.001	0.2%	0.0%	5.45 TiB
INSERT INTO cohortpeople SELECT ... FROM cohortpeople WHERE team_id = \$1 AND cohort_id = \$2 AND version < \$3 AND sign = \$4	50269ms	0.001	0.1%	0.0%	4.98 TiB
SELECT ... FROM events e WHERE team_id = \$1 AND event IN [\$2..] AND toTimeZone(timestamp, \$3) >= toDateTime(\$4..) AND toTimeZone(timestamp, \$5) <= toDateTime(\$6..) AND ((( NOT has([\$7..],...	42990ms	0.001	0.3%	0.0%	11.23 TiB
SELECT ... FROM events e WHERE team_id = \$1 AND ((event = \$2) OR (event = \$3) OR (event = \$4) OR (event = \$5) OR (event = \$6)) AND toTimeZone(timestamp, \$7) >= toDateTime(\$8..) AND toTimeZone(timestamp, \$9)...	42844ms	0.002	0.2%	0.0%	5.42 TiB
SELECT ... FROM person_overrides WHERE team_id = \$1 GROUP BY old_person_id ) AS overrides ON e.person_id = overrides.old_person_id WHERE team_id = \$2 AND event = \$3 AND toTimeZone(timestamp, \$4)...	40497ms	0.001	0.2%	0.0%	5.88 TiB
SELECT ... FROM events e WHERE team_id = \$1 AND ((event = \$2) OR (event = \$3) OR (event = \$4) OR (event = \$5) OR (event = \$6)) AND toTimeZone(timestamp, \$7) >= toDateTime(\$8..) AND toTimeZone(timestamp, \$9)...	39756ms	0.001	0.2%	0.0%	6.05 TiB










HouseWatch

- Overview
- Query performance
- Running queries
- Schema stats
- Disk usage
- Logs
- Errors
- Query editor
- Operations

ch8.posthog.net

Running queries

Query	Elapsed time	Rows read	Memory Usage	Actions
<pre>EXPLAIN header=1, indexes=1 /* user_id:25072 request:_api_projects_19279_insights_959062_ */ WITH step_runs AS ( S...</pre> <a href="#">Expand</a>	23.162638325	~108990275/155010358	1.33 GiB	<a href="#">Kill query</a>

-  Overview
-  Query performance
-  Running queries
-  Schema stats
-  Disk usage
-  Logs
-  Errors
-  Query editor
-  Operations

## Schema stats

### Largest tables

Click on the rectangles to get further information about parts and columns for the table. Note that this only covers data stored on the connected node, not the whole cluster.



### All tables

Name	Size	Rows	Engine	Partition Key
sharded_session_recording_events	13.12 TiB	657641622	ReplicatedReplacingMergeTree	toYYYYMMDD(timestamp)
sharded_events	6.92 TiB	33804432203	ReplicatedReplacingMergeTree	toYYYYMM(timestamp)
person	409.01 GiB	1703981004	ReplicatedReplacingMergeTree	
event_json_partition_statistics_mv	394.38 GiB	13447450251	MaterializedView	
.inner_id.b6f8a18b-bb59-450e-b198-456ccd524eb6	394.38 GiB	13447450251	AggregatingMergeTree	
events_plugin_ingestion_partition_statistics	372.71 GiB	9366372810	ReplicatedAggregatingMergeTree	
.inner_id.5d8e1c6e-0337-4a0e-bd46-5baa1b136978	134.06 GiB	9947057803	MergeTree	
persons_properties_view	134.06 GiB	9947057803	MaterializedView	
trace_log	117.87 GiB	5646664094	MergeTree	toYYYYMM(event_date)
person_distinct_id2	109.00 GiB	1914693902	ReplicatedReplacingMergeTree	

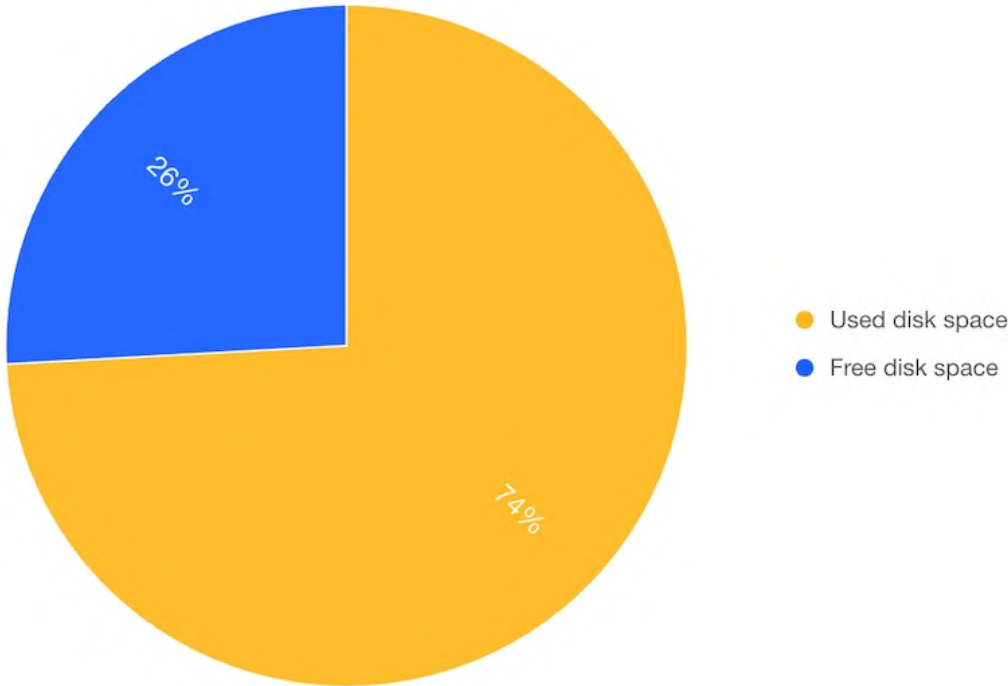




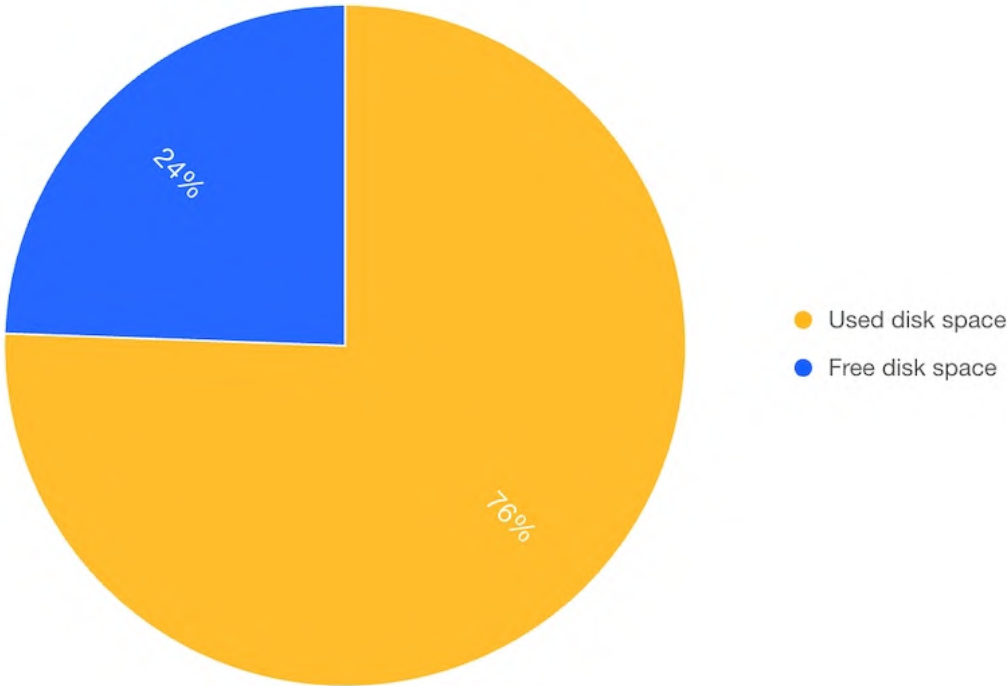
- Overview
- Query performance
- Running queries
- Schema stats
- Disk usage**
- Logs
- Errors
- Query editor
- Operations

Disk usage

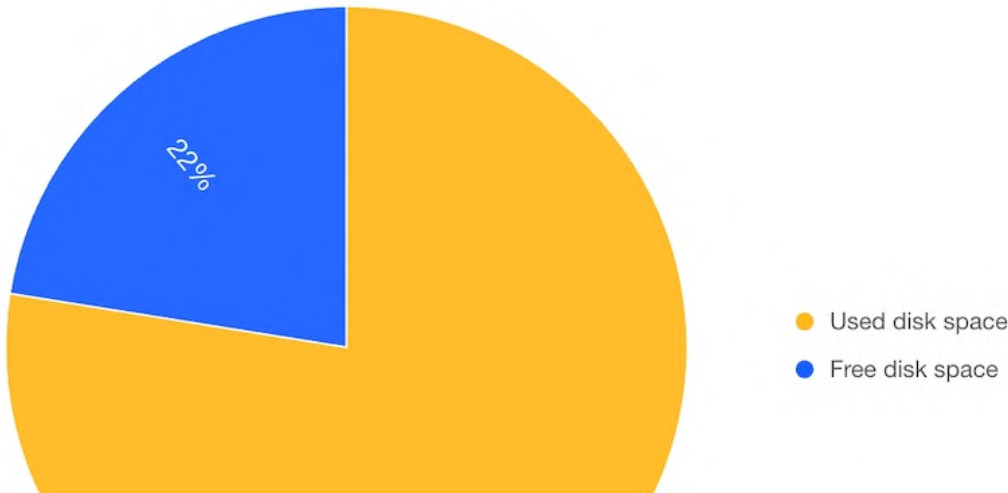
ch9.posthog.net



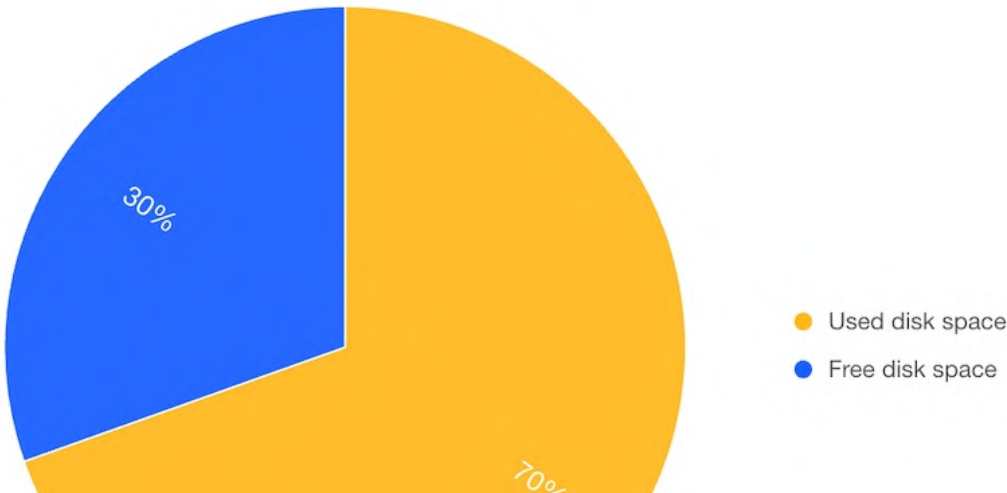
ip-172-31-44-98



ip-172-31-47-136

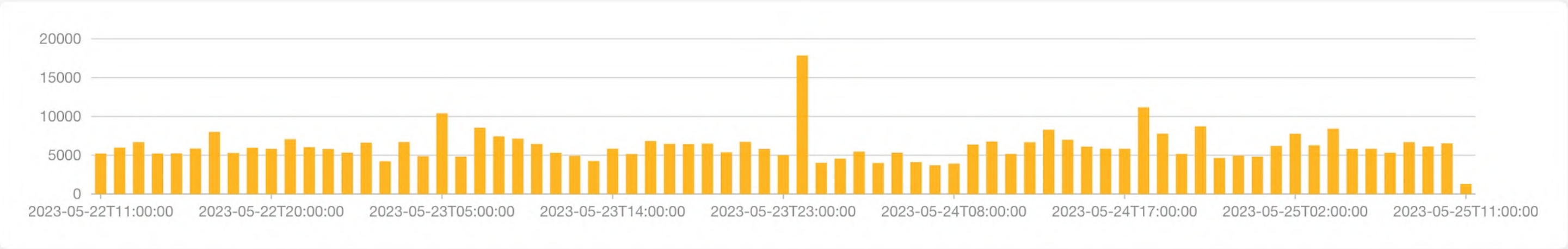


ip-172-31-65-101



- Overview
- Query performance
- Running queries
- Schema stats
- Disk usage
- Logs
- Errors
- Query editor
- Operations

Logs



Time	Level	Host	Message
2023-05-25T11:07:23	Error	ip-172-31-65-101	auto DB::StorageReplicatedMergeTree::processQueueEntry(ReplicatedMergeTreeQueue::SelectedEntryPtr)::(anonymous class)::operator()(DB::StorageReplicatedMergeTree::LogEntryPtr &) const: Poco::Except... <a href="#">Expand</a>
2023-05-25T11:07:20	Error	ip-172-31-65-101	auto DB::StorageReplicatedMergeTree::processQueueEntry(ReplicatedMergeTreeQueue::SelectedEntryPtr)::(anonymous class)::operator()(DB::StorageReplicatedMergeTree::LogEntryPtr &) const: Poco::Except... <a href="#">Expand</a>
2023-05-25T11:07:19	Error	ip-172-31-65-101	auto DB::StorageReplicatedMergeTree::processQueueEntry(ReplicatedMergeTreeQueue::SelectedEntryPtr)::(anonymous class)::operator()(DB::StorageReplicatedMergeTree::LogEntryPtr &) const: Poco::Except... <a href="#">Expand</a>
2023-05-25T11:07:18	Error	ip-172-31-65-101	auto DB::StorageReplicatedMergeTree::processQueueEntry(ReplicatedMergeTreeQueue::SelectedEntryPtr)::(anonymous class)::operator()(DB::StorageReplicatedMergeTree::LogEntryPtr &) const: Poco::Except... <a href="#">Expand</a>



- Overview
- Query performance
- Running queries
- Schema stats
- Disk usage
- Logs
- Errors
- Query editor
- Operations

## Operations (Alpha)

Create long-running operations to run in the background in your ClickHouse cluster. Useful for large data migrations, specify SQL commands to run in order with corresponding rollbacks, such that if the operation fails, you rollback to a safe state.

Please exercise caution! This funtionality is still in Alpha.

Operations [Create new operation](#)

### Details

Description

### Operations

#1

```
CREATE TABLE test_table ( foo String ) Engine=MergeTree()
```

```
DROP TABLE IF EXISTS test_table
```





---

[github.com/posthog/housewatch](https://github.com/posthog/housewatch)





# Thank you!

We're hiring [posthog.com/careers](https://posthog.com/careers)