OSA CON 24

Exploring data analysis in time series databases

Aliaksandr Valialkin, CTO at VictoriaMetrics

November 19-21, 2024

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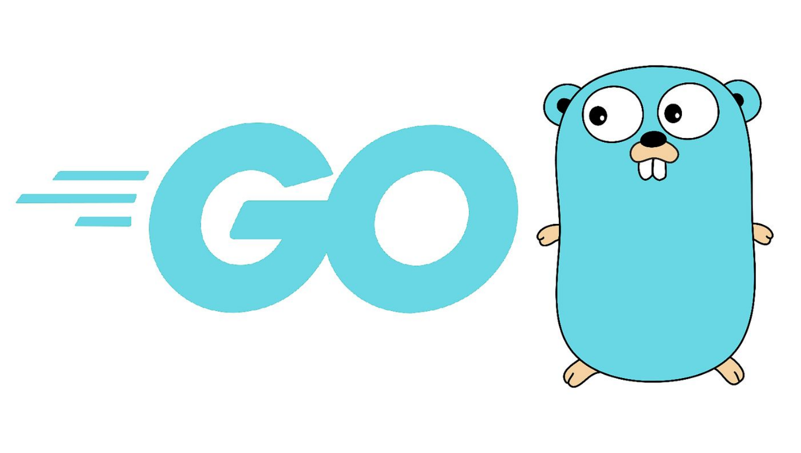
- I like writing fast programs in Go
  - Go is easy to use
  - Go is productive
  - Go programs can be fast



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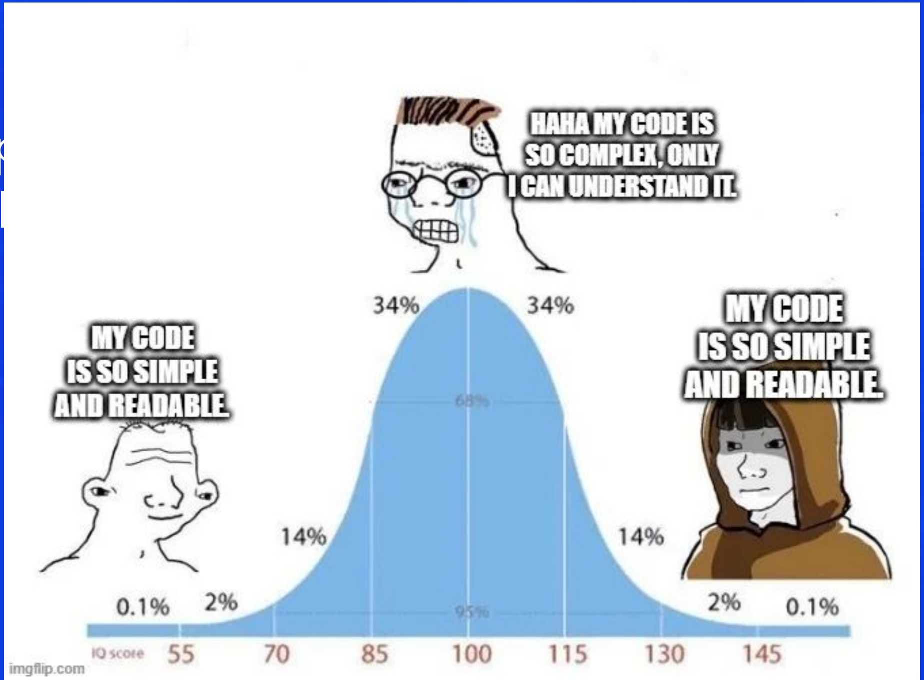
HAHA MY CODE IS SO COMPLEX, ONLY I CAN UNDERSTAND IT.
MY CODE IS SO SIMPLE AND READABLE.
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34%
34%
68%
14%
14%
2%
2%
0.1%
0.1%
95%
IQ score
55
70
85
100
115
130
145
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  - Impossible to debug and recover when the “magic” breaks

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- I’m inspired by ClickHouse focus on performance

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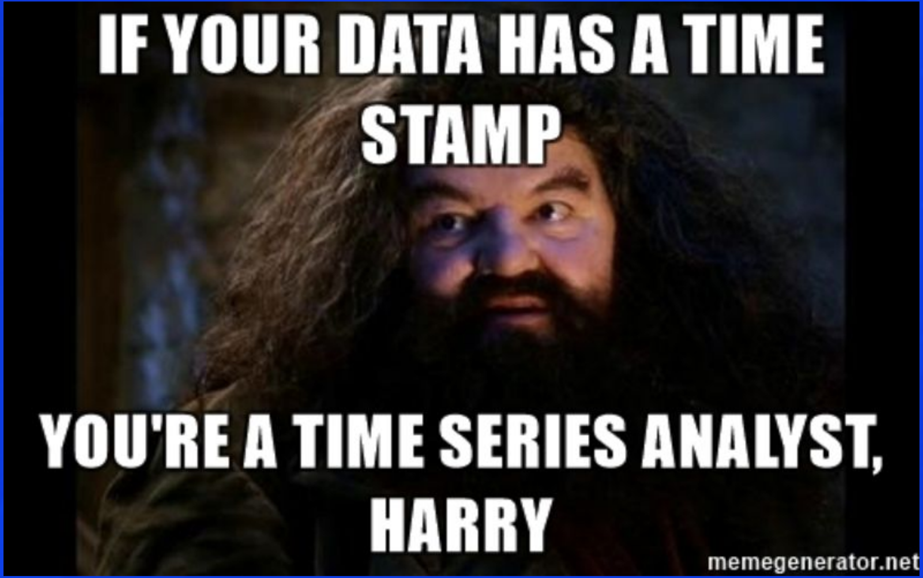
IF YOUR DATA HAS A TIME STAMP
YOU'RE A TIME SERIES ANALYST, HARRY
memegenerator.net

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  - memory_usage{host=”foo”,env=”prod”,az=”us-east”}

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  - temperature{city="NY",country="US"}
  - memory_usage{host="foo",env="prod",az="us-east"}
- The set of (label=value) labels remain constant across all the (timestmap; value) samples, which belong to the same time series

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  - cpu_usage_percent{host=”foo”,env=”prod”}: (10:20:30; 50%), … (23:34:59; 12%)

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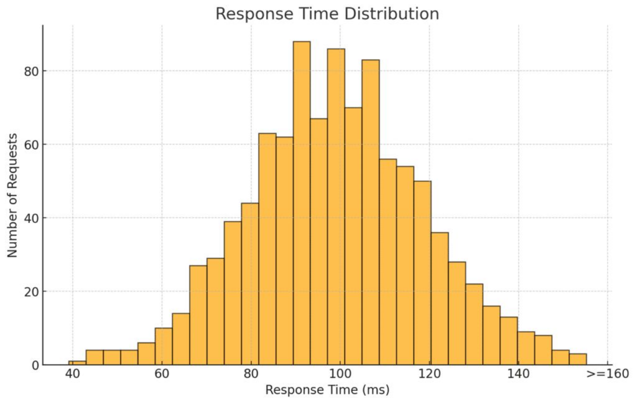

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  - Wide events - every value contains hundreds of (field=value) fields

My knowledge about TV series
My knowledge about time series

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  - OpenTelemetry for logs, traces and metrics
  - Prometheus text exposition format
  - Graphite metrics format
  - Influx line protocol
  - Elasticsearch for logs

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  - Mixed - InfluxDB, ClickHouse

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    - Database optimized for time series data: makes a few sequential reads for fetching a million of samples for the typical query, while reading 1MB of data from disk

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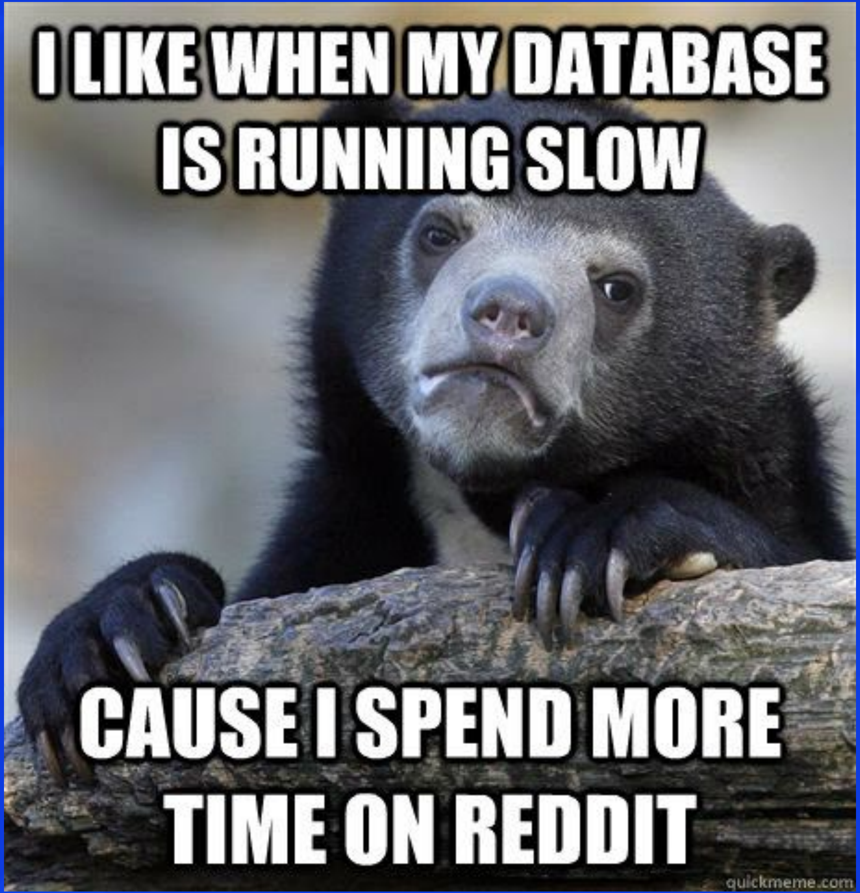
    - Time series database: occupies a few GiB of RAM for sparse index over 10 trillions of rows


I LIKE WHEN MY DATABASE IS RUNNING SLOW
CAUSE I SPEND MORE TIME ON REDDIT
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  - A thousand of containers, which expose 500 metrics each, and these metrics are stored into database per every 10 seconds, generate 1000*500*(24*3600/10)=4.32 billions of samples per day
  - A thousand of containers, which generate 100 events (logs) per second each, result in 1000*10*24*3600=8.64 billions of events per day

Challenges with Kubernetes monitoring

- All these samples must be **efficiently** stored, so they occupy the smallest possible amounts of disk space

Challenges with Kubernetes monitoring

- All these samples must be efficiently stored, so they occupy the smallest possible amounts of disk space
- All these samples must be efficiently queried with a query language optimized for typical monitoring tasks: alerting, analyzing dashboards with graphs for the requested metrics/logs/events over the selected time range

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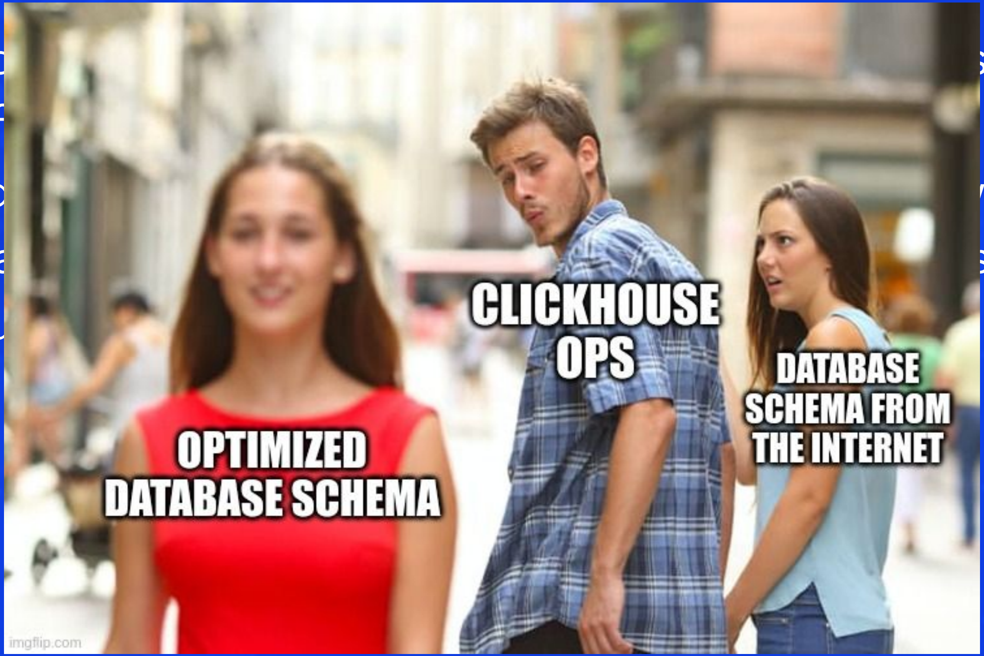

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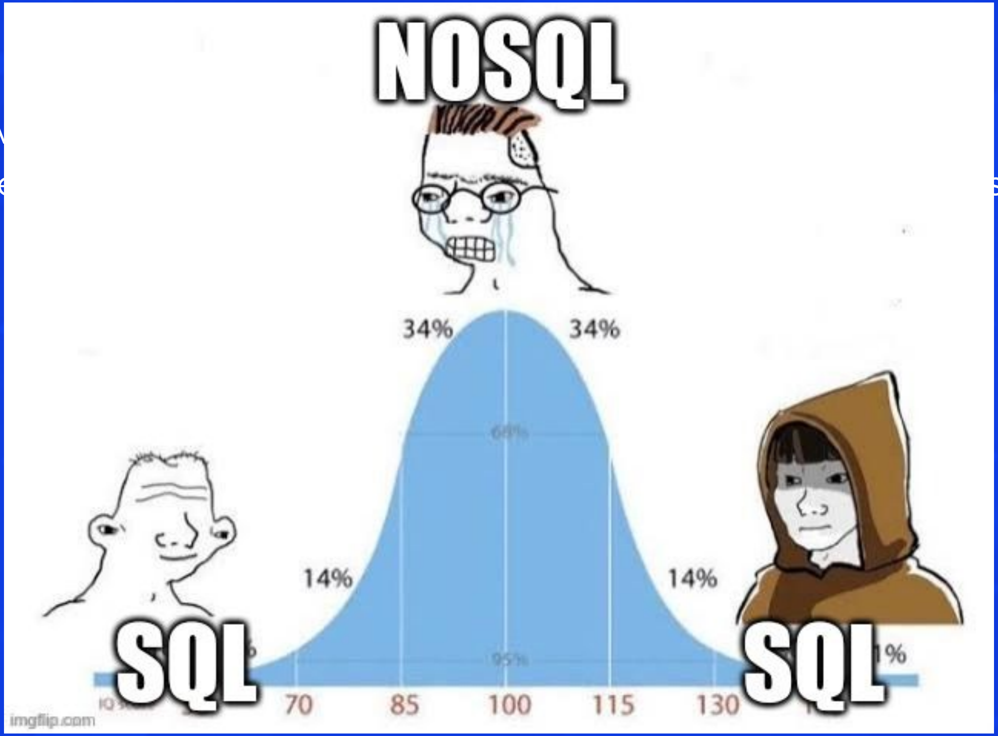

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  - Easier to write queries for typical monitoring use cases
  - You need to learn yet another query language
  - Some queries are harder or impossible to write

Typical data analysis tasks for time series data

- Select time series with the given set of labels

SQL

```
SELECT
  id
FROM
  series
WHERE
  hasAll(labels, ['label1=value1', ... 'labelN=valueN'])
```

Typical data analysis tasks for time series data

- Select time series with the given set of labels

PromQL

```
{label1="value1", ... labelN="valueN"}
```

Typical data analysis tasks for time series data

- Select time series with the given set of labels
- Select samples for the selected time series on the given time range

SQL

```sql
SELECT
  series_id
  timestamp,
  value
FROM samples
WHERE
  series_id IN (<query_from_the_previous_slide>)
  AND timestamp > $start AND timestamp <= $end
```

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PromQL

```
{label1="value1", ... labelN="valueN"}[$__range]

/api/v1/query?time=$end&query=...
```

Typical data analysis tasks for time series data

- Select time series with the given set of labels
- Select samples for the selected time series on the given time range
- Apply some aggregations over the selected time series

SQL

```
SELECT
  series_id,
  avg(value) AS avg_value
FROM (<query_from_the_prevous_slide>)
GROUP BY
  series_id
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- Select time series with the given set of labels
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PromQL

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avg_over_time({label1="value1", ... labelN="valueN"}[$__range])
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Typical data analysis tasks for time series data

- Select time series with the given set of labels
- Select samples for the selected time series on the given time range
- Apply some aggregations over the selected time series
- Apply some filters on the calculated aggregates

SQL

```
SELECT
  series_id,
  avg_value
FROM (<query_from_the_prevous_slide>)
WHERE avg_value > $threshold
```

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      value
    FROM samples
    WHERE
      series_id IN (
        SELECT id FROM series WHERE hasAll(labels, ['label1=value1', ... 'labelN=valueN'])
      )
      AND timestamp > $start AND timestamp <= $end
  )
  GROUP BY series_id
)
WHERE avg_value > $threshold
```

The resul

```
SELECT
  series_id,
  avg_value
FROM (
  SELECT
    series_id,
    avg(value)
  FROM (
    SELECT
      series_id
      value
    FROM san
    WHERE
      series_id
        SELECT
      )
      AND tim
  )
  GROUP BY
)
WHERE avg_
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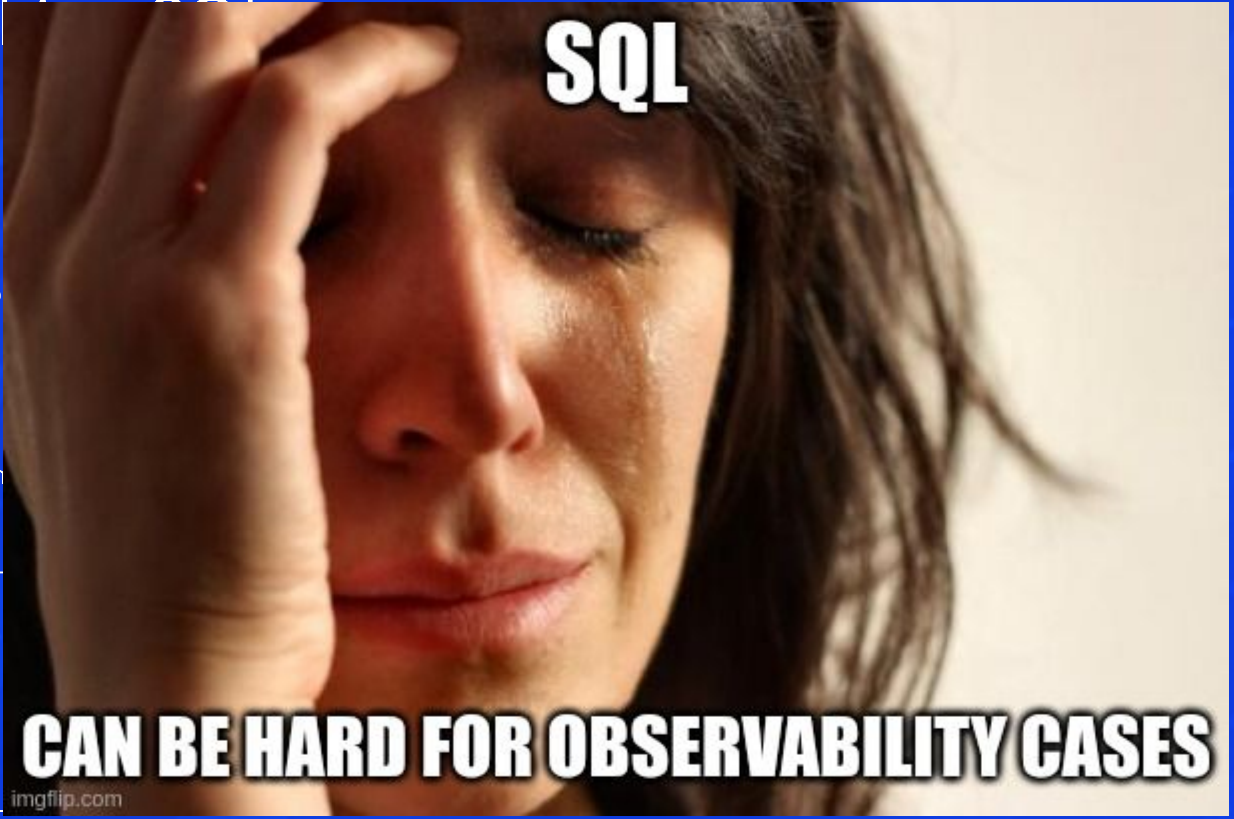

Example queries: SQL vs PromQL

Select temperature in NY city on the given time range

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SQL

```
SELECT
  date_trunc('$__step', timestamp) AS timestamp_truncated,
  last_value(value) AS temperature
FROM
  metrics
WHERE
  series_id IN (
    SELECT id FROM series
    WHERE __name__ = 'temperature' AND city = 'NY'
  )
  AND timestamp > now() - $__range AND timestamp < now()
GROUP BY
  timestamp_truncated
ORDER BY
  timestamp_truncated
```

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```

PromQL or MetricsQL

```
temperature{city="NY"}
```

Example queries: SQL vs LogsQL

Select top 5 applications with the biggest number of error logs, which do not contain “broken pipe” phrase during the last day

Example queries: SQL vs LogsQL

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SQL

```
SELECT
  app,
  count(*) hits
FROM
  logs
WHERE
  timestamp > now() - 1 day AND timestamp <= now()
  AND level = 'error'
  AND positionUTF8(_msg, 'broken pipe') = 0
GROUP BY
  app
ORDER BY
  hits DESC
LIMIT 5
```

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LogsQL

```
_time:1d level:=error -"broken pipe"
    | top 5 by (app)
```

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Select the number of apps with more than 10 error logs per each step on the graph

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SQL

```
SELECT
  timestamp_trucated,
  count()
FROM (
  SELECT
    date_trunc('$__step', timestamp) AS timestamp_truncated,
    app,
    count(*) hits
  FROM logs
  WHERE
    timestamp >= now() - $__range AND timestamp < now()
    AND level = 'error'
  GROUP BY timestamp_truncated, app
  HAVING hits > 10
)
GROUP BY timestamp_truncated
ORDER BY timestamp_truncated
```

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  HAVING hits > 10
)
GROUP BY timestamp_truncated
ORDER BY timestamp_truncated
```

LogsQL

```
level:=error
    | stats by (app) count() as hits
    | hits:>10
    | count()
```

Why PromQL and LogsQL is easier than SQL for graph building in Grafana?

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  - /api/v1/query_range?start=…&end=…&step=…&query=…
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  - /select/logsql/stats_query_range?start=...&end=...&step=...&query=...
- The query is automatically executed per every **step** on the **[start … end]** time range
- The query results are grouped and returned per each step at the following timestamps: **start, start+step, start+2*step, … end**

Conclusions

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  - What about traces?

Conclusions

- Typical tin
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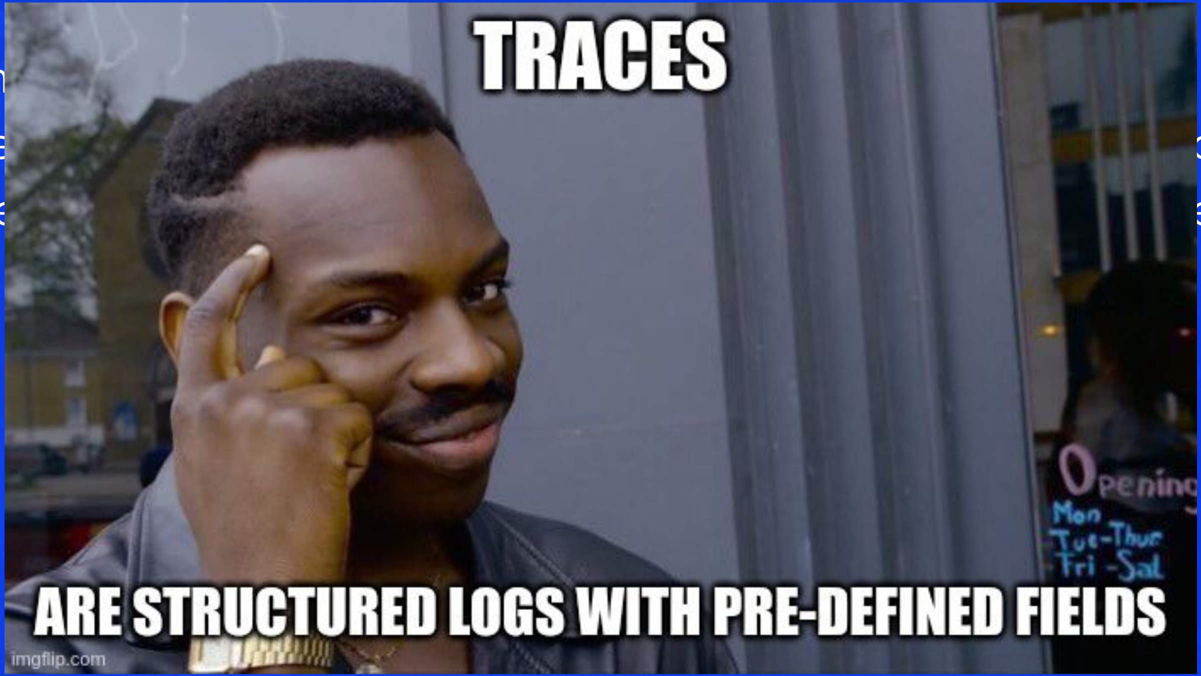
- Time serie events



Conclusions

- Typical time series data volumes do not fit relational databases
- Prefer specialized databases for storing and querying time series data
- Time series data includes: metrics, logs, events and wide events
- Prefer specialized databases for particular time series data types

RDBMS
TSDB
DEVOPS DECIDING WHICH DATABASE TYPE TO USE FOR TIME SERIES DATA
JAKE-CLARK.TUMBLR
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Questions?

- ClickHouse docs - https://clickhouse.com/docs
- VictoriaMetrics docs - https://docs.victoriametrics.com/
- VictoriaLogs docs - https://docs.victoriametrics.com/victorialogs/
- LogsQL docs - https://docs.victoriametrics.com/victorialogs/logsql/