Prometheus

a practical workshop v1.1

Tomer Gabel, November 2024

The Pillars of Observability

1. Logs
2. Metrics
3. Traces

The Pillars of Observability

1. ~~Logs~~
2. Metrics
3. ~~Traces~~

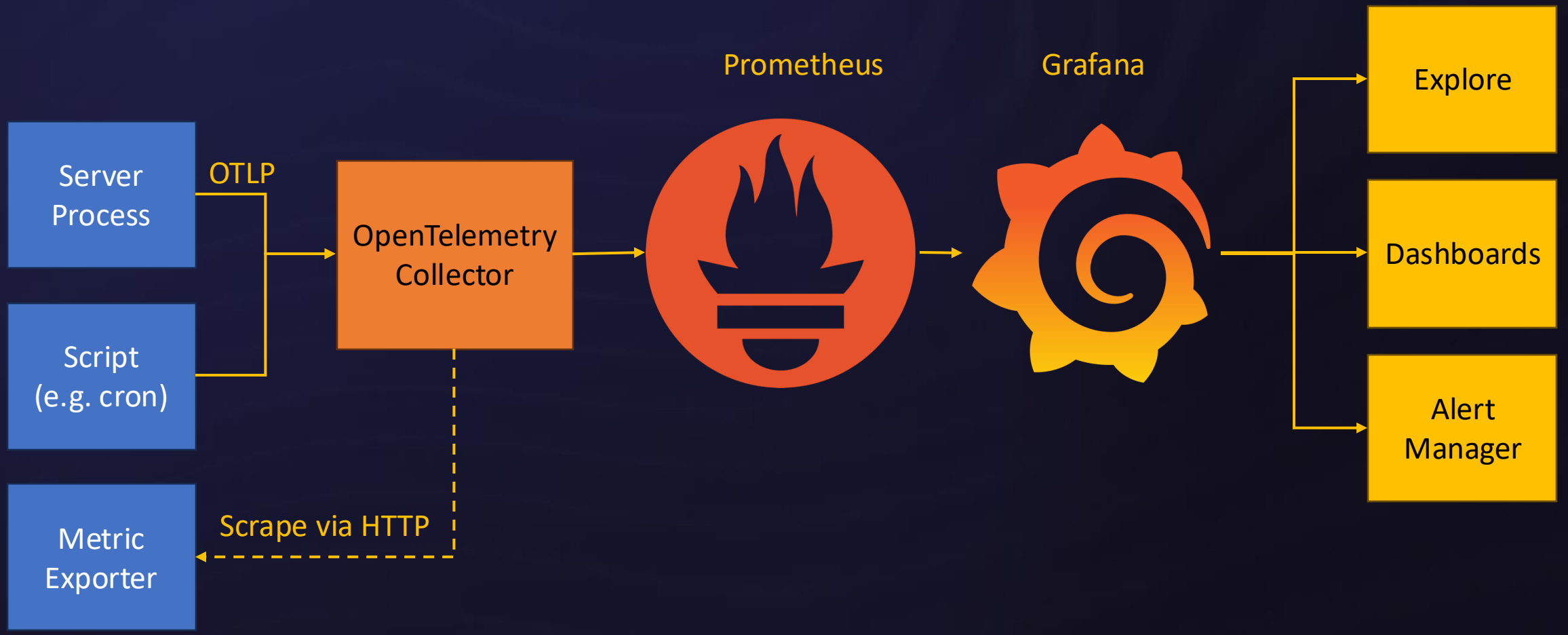
Our focus today.

Metrics:

Answer *quantitative* questions

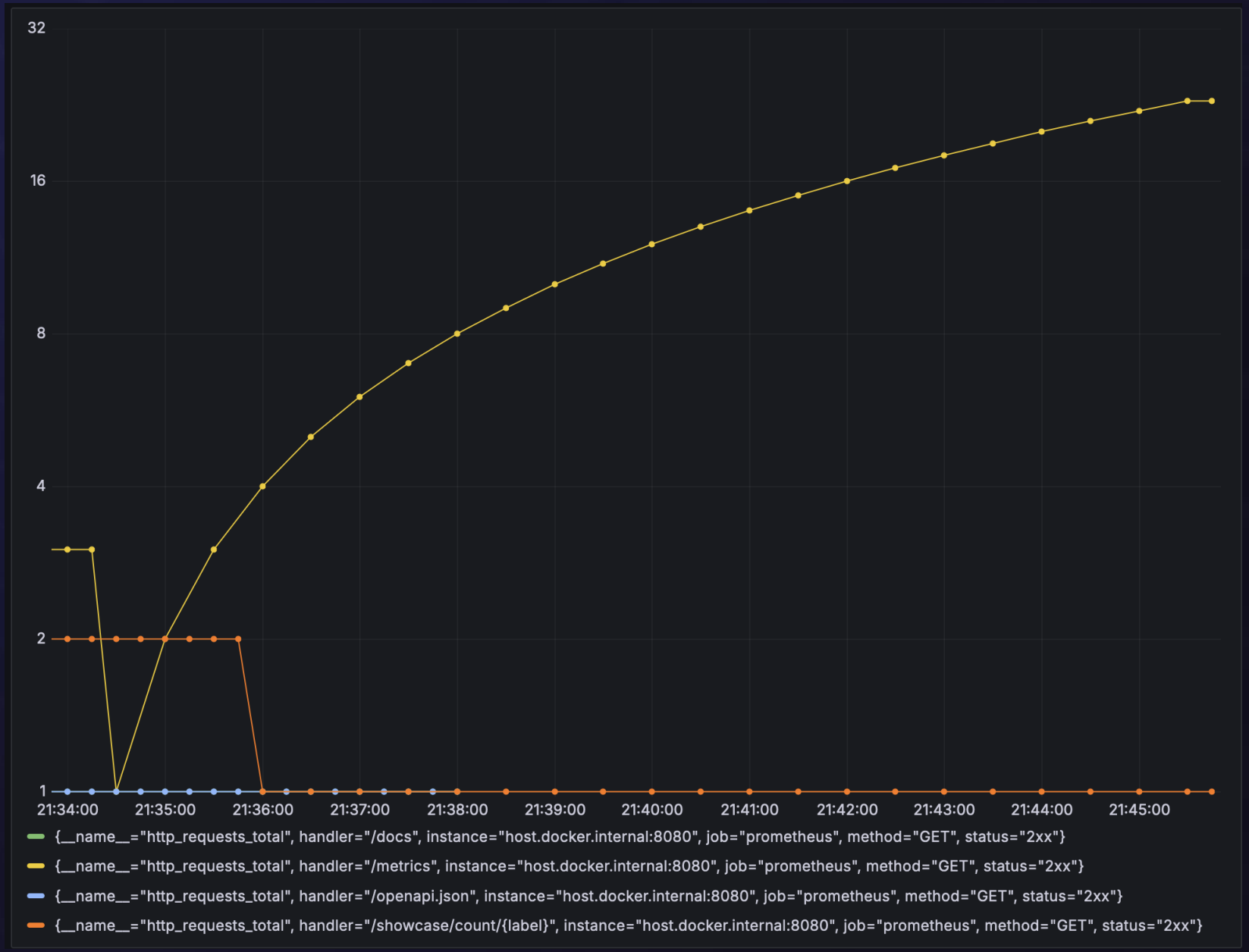
1. *How many* requests did I get?
2. *How long* did they take to process?
3. *How much* memory am I using?
4. *How much* free space is left on the disk?

Enter: Prometheus



Metrics 101

1. Name
2. Labels
3. Time
4. Value



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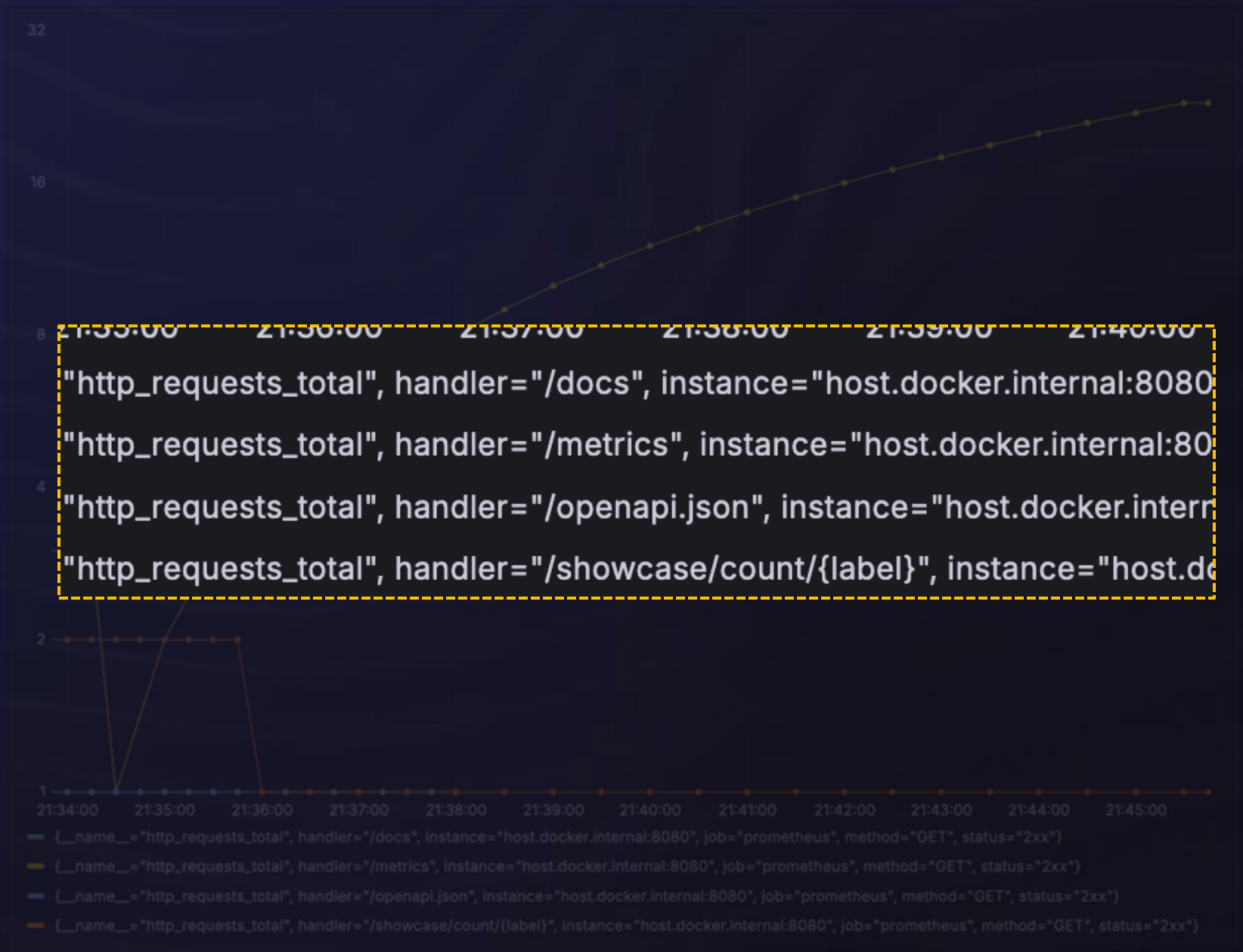

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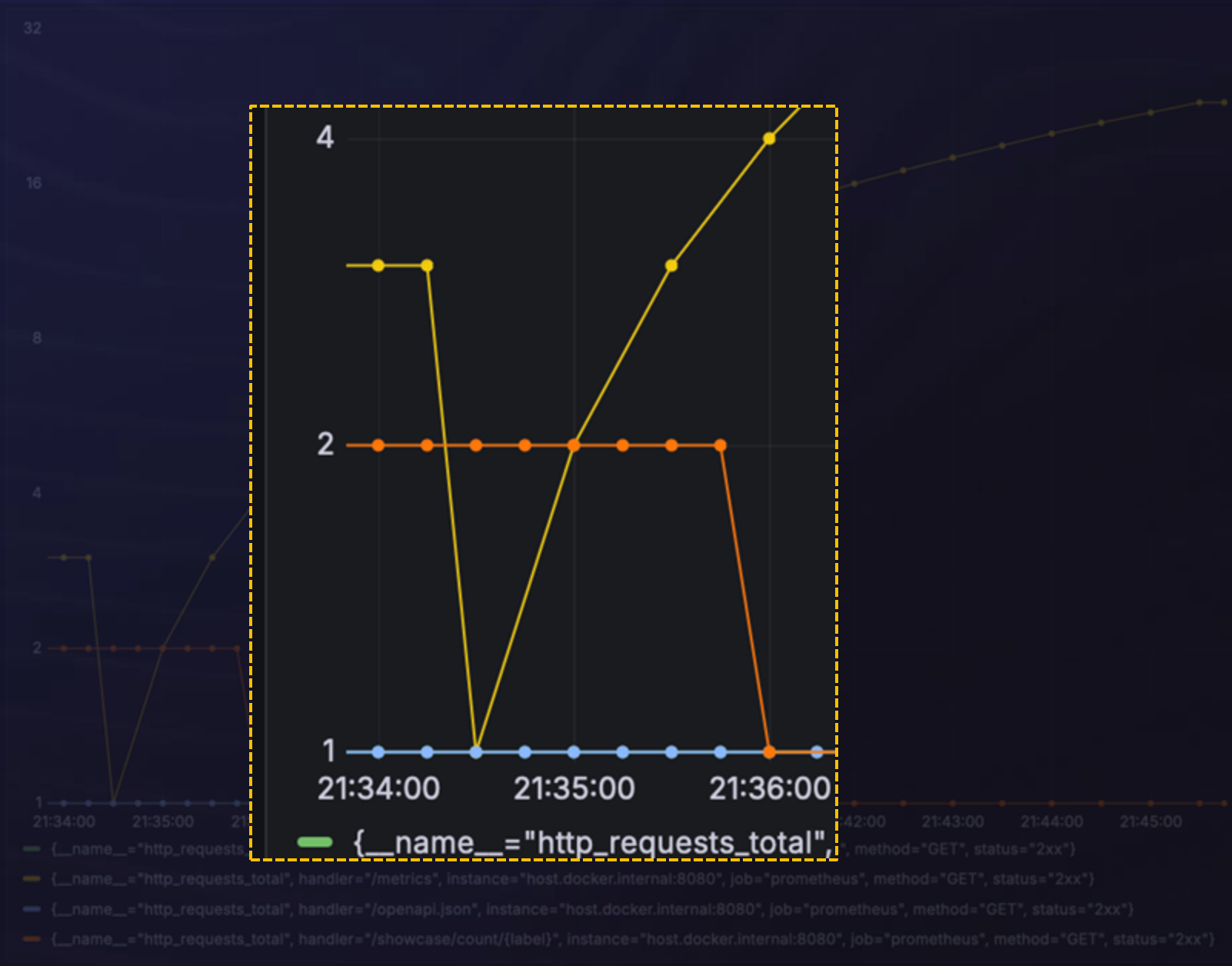


A word on cardinality

1. Prometheus is analogous to a *flat database*
   - Partitioned by *time*
   - Labels are like *indexed columns*
2. The DB size is therefore:
   - Timeframe * # labels * # *label values*

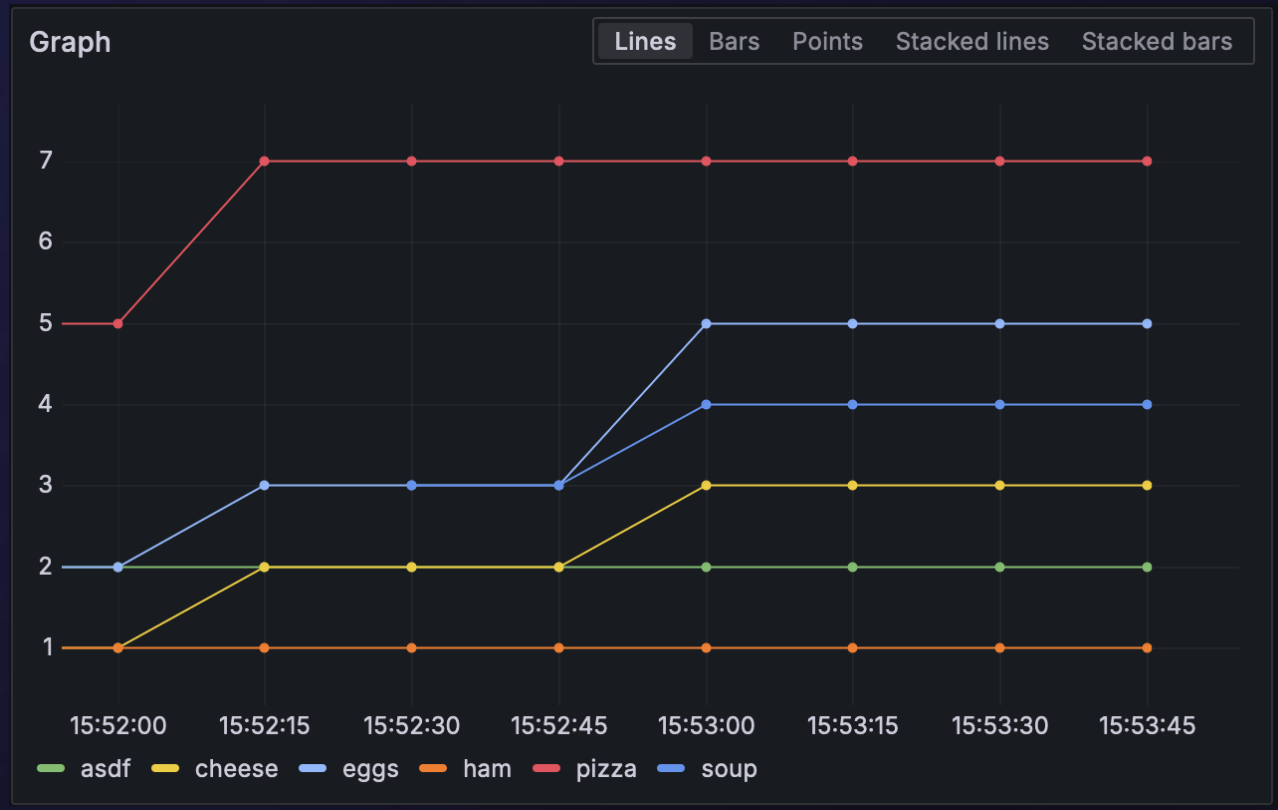
Prometheus metric types: Counter

1. As the name implies, a metric that *counts*
2. Can go up or down by any amount
3. *Stateful* – value managed by *Prometheus*
4. Examples:
   - # of server requests (by method, path, …)
   - # of events (“times a user logged in”)

Counting the Python way

```
counter = meter.create_counter(
    "my_count",
    description="Event count"
)

@router.get("/count/{label}")
def count(label: str) -> dict:
    counter.add(1, {"my_label": label})
    return {"status": "ok"}
```



Prometheus metric types: Gauge

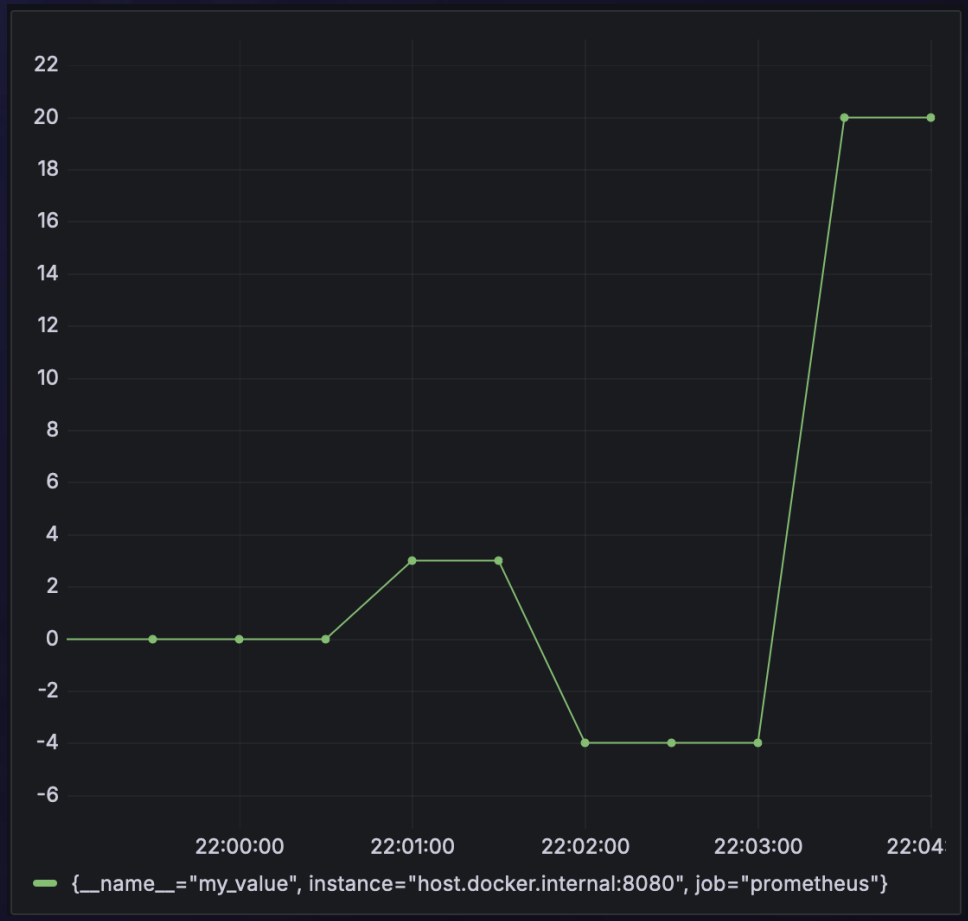
1. A metric that is sampled *on demand*
2. Each sample is *independent*
3. Common examples:
   - CPU core temperature in ℃
   - Free space on /dev/sda2

Gauging the Python way

```
gauge = meter.create_gauge(
    "my_value",
    description="Some stateful value"
)

class GaugeData(BaseModel):
    value: int

@router.put("/gauge")
def gauge_value(data: GaugeData) -> dict:
    gauge.set(data.value)
    return {"status": "ok"}
```



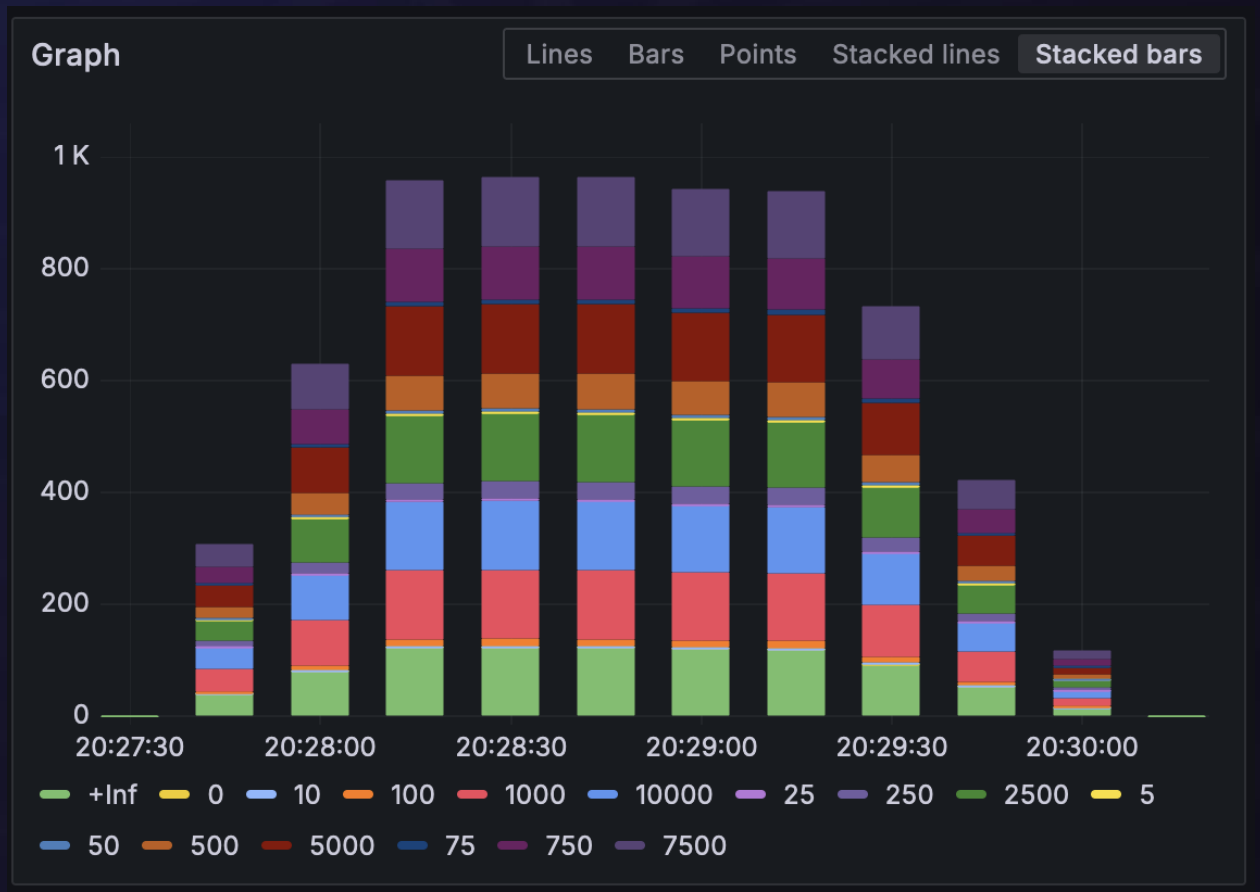
Prometheus metric types: Histograms

1. Some metrics *cannot be represented* with one value
   - "*How long* do requests to /login take?"
   - Do you mean average? Mean? 90th percentile?
2. These values prdoduce a *distribution*
3. Managed with buckets. Latency, for example:
   - 0–10ms, 10–100ms, 100–1000ms, …

Histograms the Python way

```
histogram = meter.create_histogram(
    "my_duration",
    unit="ms",
    description="Event duration"
)


@router.get("/duration/{length_ms}")
def duration(length_ms: int) -> dict:
    histogram.record(length_ms)
    return {"status": "ok"}
```



Not all histograms are made equal

Latencies vary wildly (ms vs second), as do *sizes* (payload in KB, disk in GB).

Views to the rescue!

```
duration_view = View(
    instrument_name="my_duration",
    aggregation=ExplicitBucketHistogramAggregation(range(0, 10000, 500)),
)
meter_provider = MeterProvider(
    metric_readers=[oltp_exporter],
    views=[duration_view],
)
set_meter_provider(meter_provider)
```

Lab Time

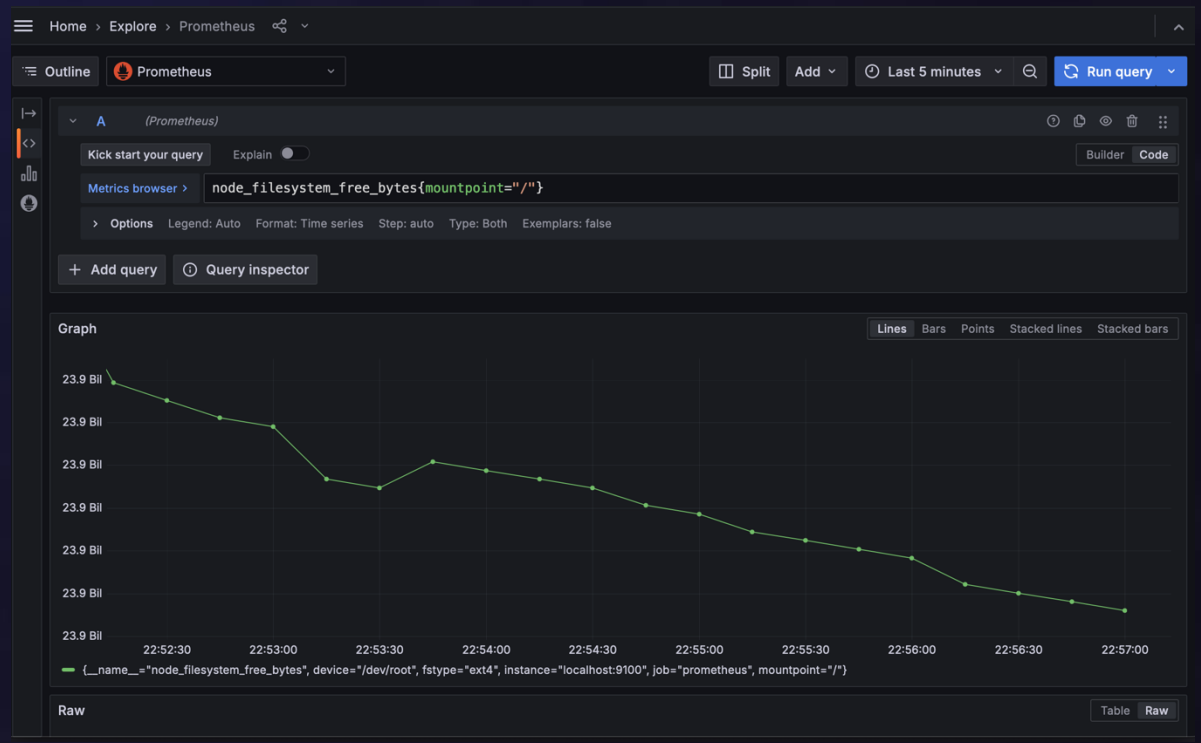
Showcase

1. F*amiliarize yourself* with the lab setup
2. *Get handsy* with Grafana
3. Open lab-showcase from the *class materials*
4. You have *30 minutes* to explore!

Part 2: PromQL

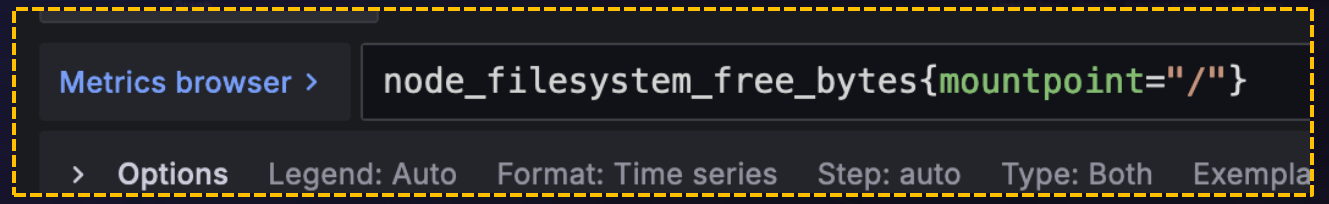
PromQL: Fear, Terror and Ruthless Efficiency

1. Extensive, powerful
2. … not entirely trivial



PromQL: Fear, Terror and Ruthless Efficiency

1. Extensive, powerful
2. … not entirely trivial
3. Basically:
   - A *query*
   - A *timeframe*



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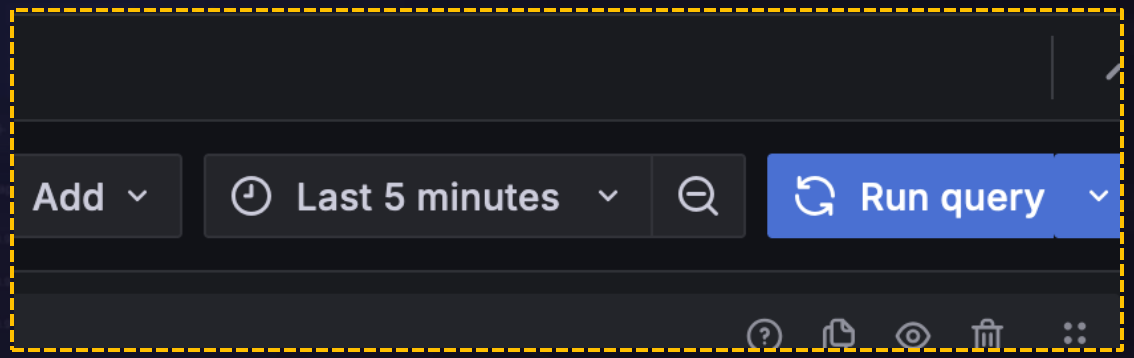
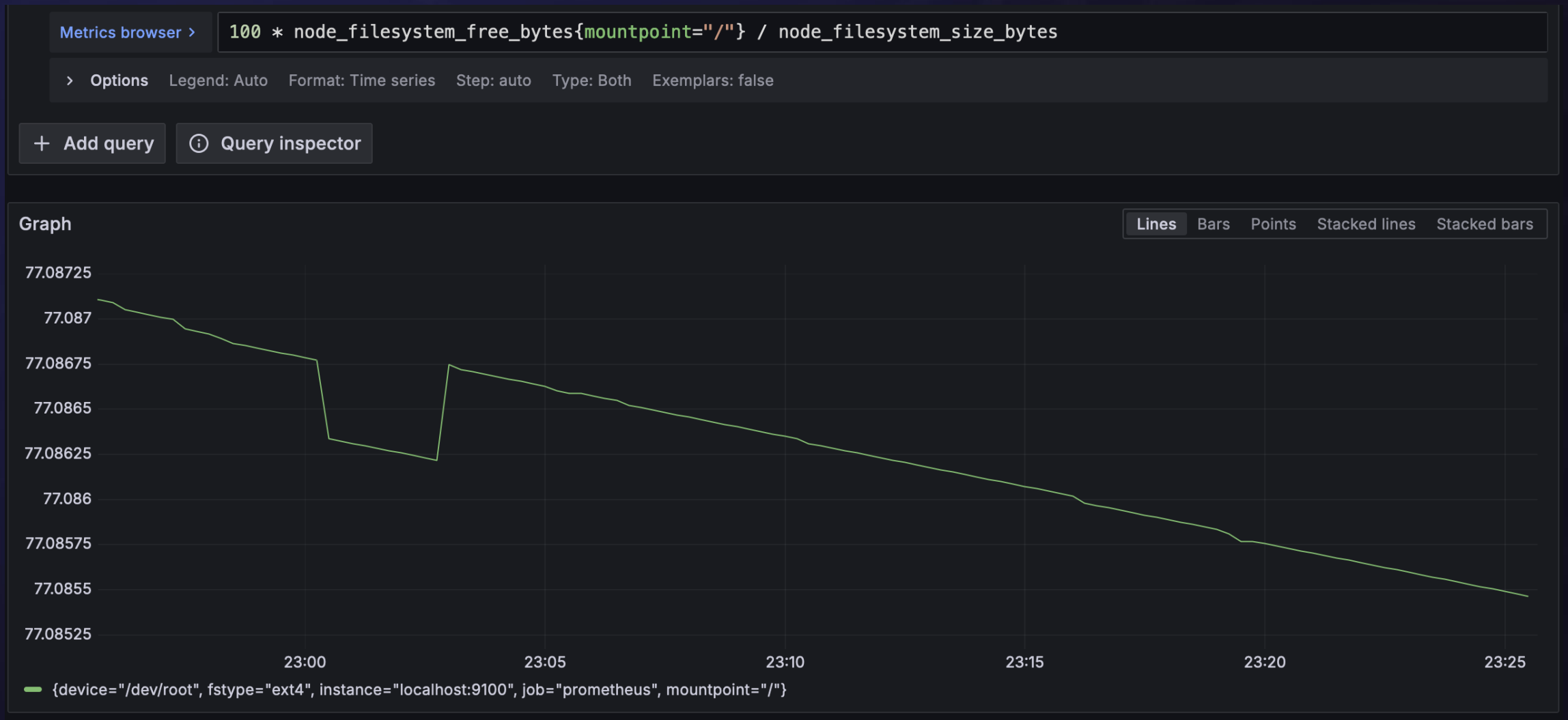


PromQL: Maths!

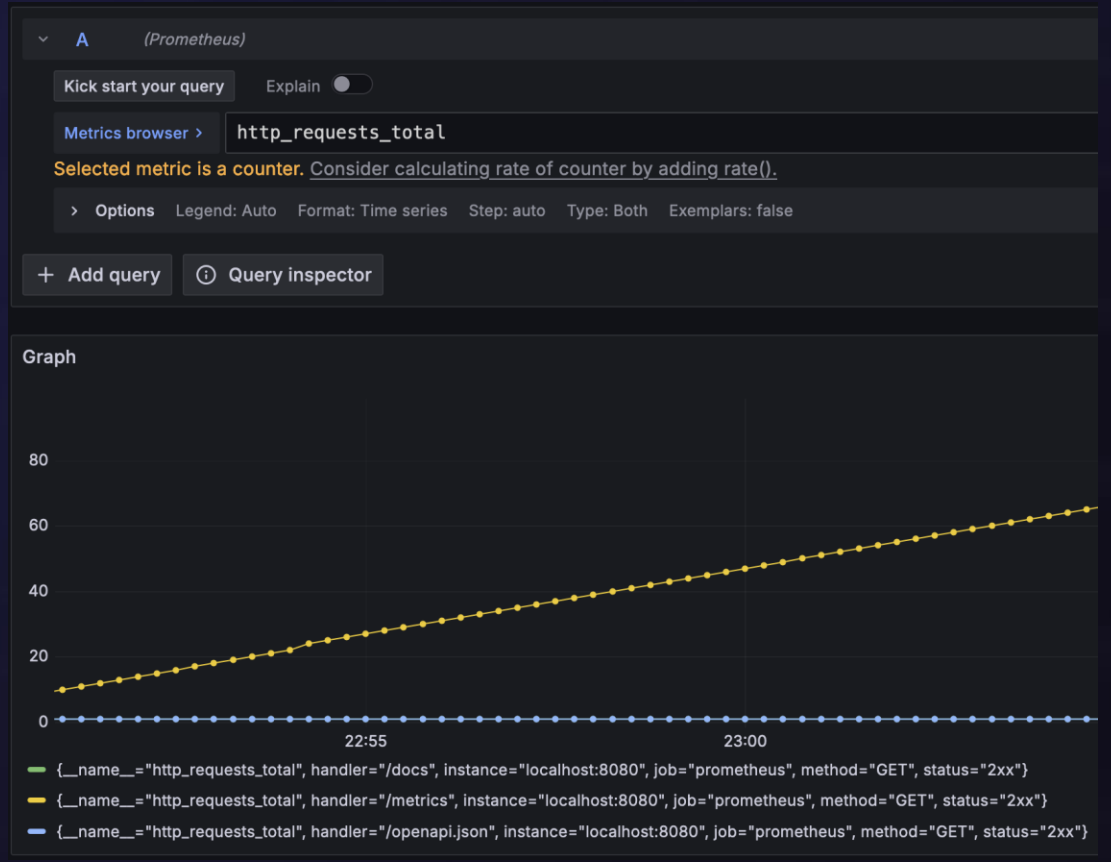
1. [Metric, labels, time] yields one value
2. Some observations require *multiple* values
3. Expressed with basic arithmetic:
   - % free disk space = *free* disk bytes/*total* disk bytes
   - % CPU = *CPU used seconds* / (# seconds * # cores)

PromQL: Maths



PromQL: Rates

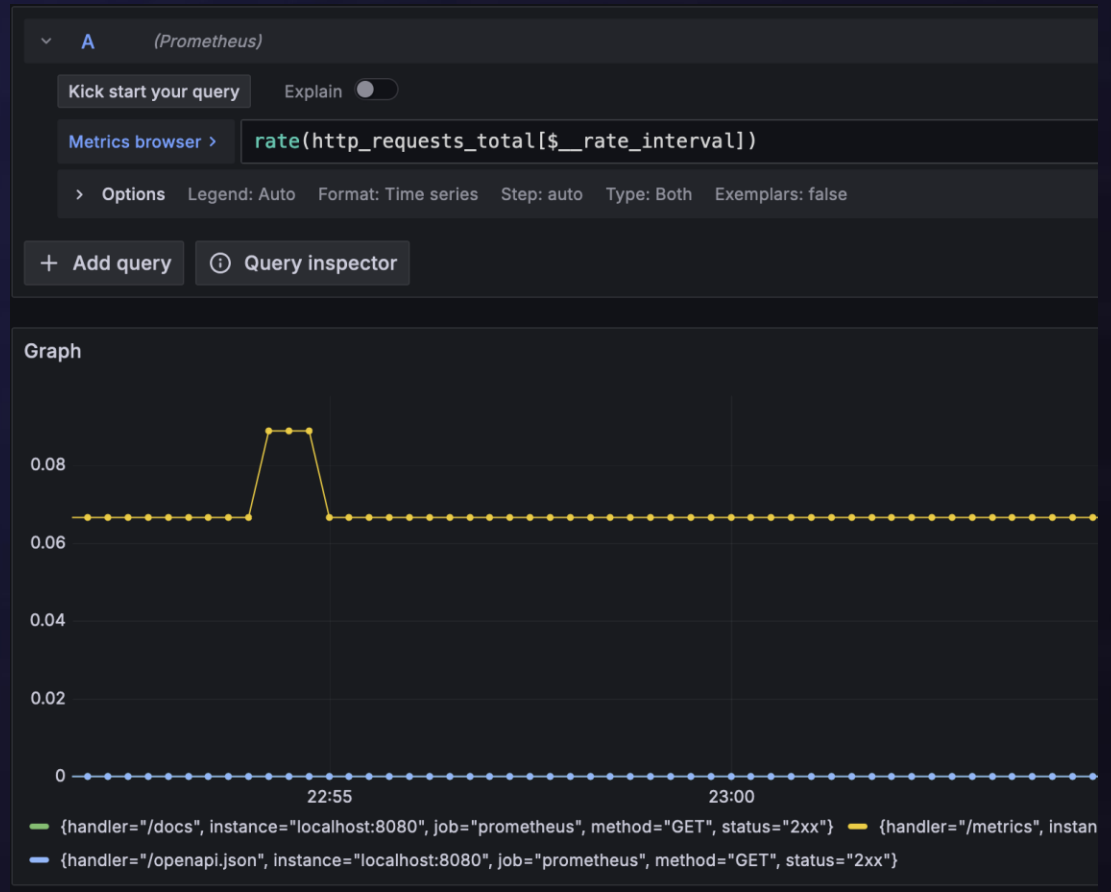
1. Counters are very useful
2. Can't use them *naïvely*



PromQL: Rates

1. Counters are very useful
2. Can't use them *naïvely*
3. We need a *rate derivation*
4. Magic incantation for the win:

   rate(metric{…}[$__rate_interval])



PromQL: Aggregations

1. Consider *http_server_duration_milliseconds_count*
   - A simple counter
   - Potentially many services, paths
2. Suppose you want the grand total?

   sum(http_server_duration_milliseconds_count)

PromQL: Aggregations

1. Consider *http_server_duration_milliseconds_count*
   - A simple counter
   - Potentially many services, paths
2. How about the 5 most used paths?

   topk(5, http_server_duration_milliseconds_count)

PromQL: Aggregations

1. What are the top 3 most time-consuming endpoints?

   topk(3, http_server_duration_milliseconds_sum)

2. How many processes run which Python version?

   count by (major) (python_info)

3. What is the highest rate of pagefaults recorded?

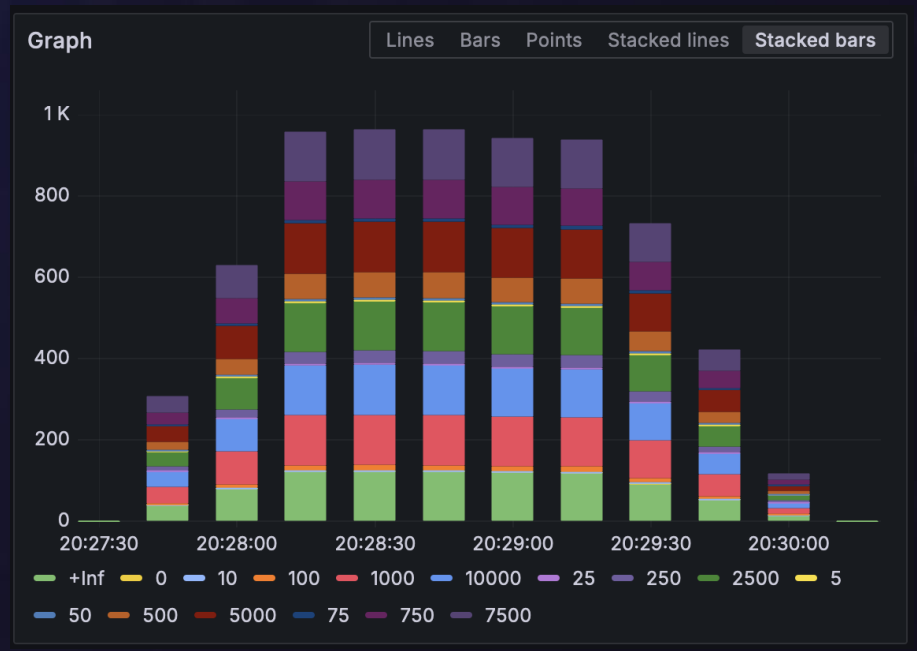
   max(rate(node_vmstat_pgfault[$__rate_interval]))

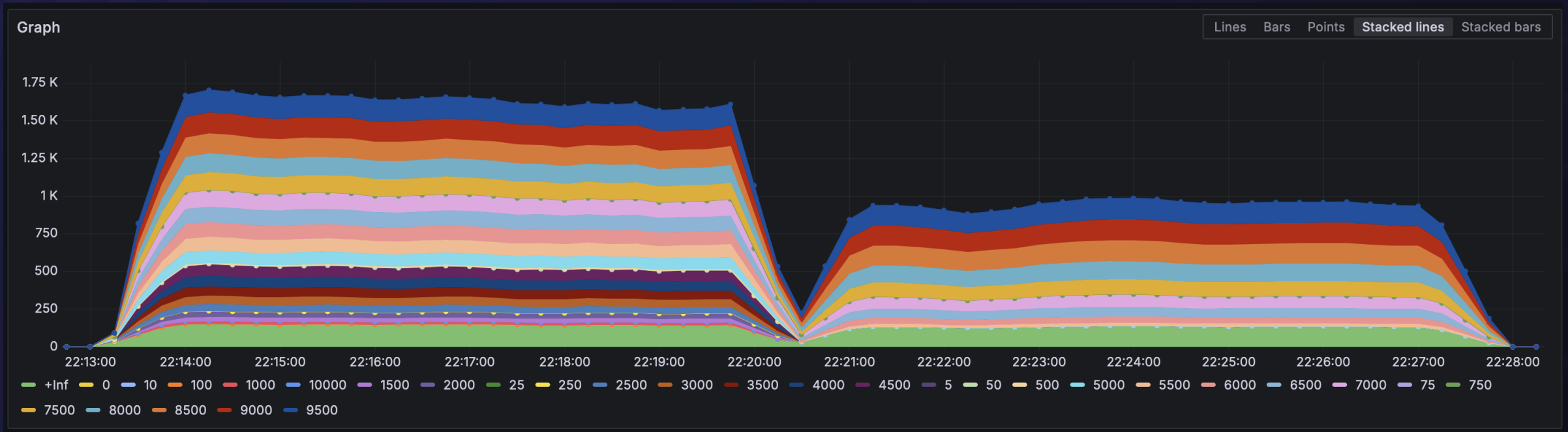
And now, what you've all been waiting for

Quantiles (a.k.a. percentiles)

1. A histogram is a set of *counters*
   - 0-100ms, 100-200ms, 200-300ms…
2. What is the 95th *percentile*?
   - Linear regression FTW… but maths!
3. PromQL to the rescue:

   histogram_quantile(0.99, http_server_duration_milliseconds_bucket)




Graph
Lines
Bars
Points
Stacked lines
Stacked bars
1.75 K
1.50 K
1.25 K
1 K
750
500
250
0
22:13:00
22:14:00
22:15:00
22:16:00
22:17:00
22:18:00
22:19:00
22:20:00
22:21:00
22:22:00
22:23:00
22:24:00
22:25:00
22:26:00
22:27:00
22:28:00
+Inf
0
10
100
1000
10000
1500
2000
25
250
2500
3000
3500
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4500
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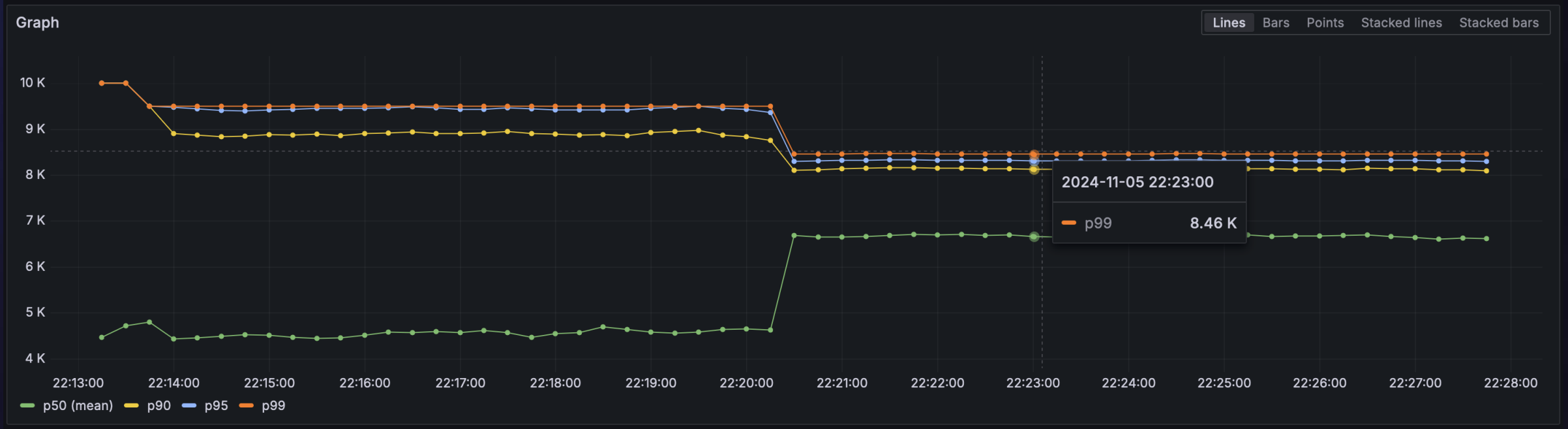
50
500
5000
5500
6000
6500
7000
75
750
7500
8000
8500
9000
9500


Graph
Lines
Bars
Points
Stacked lines
Stacked bars
10 K
9 K
8 K
7 K
6 K
5 K
4 K
2024-11-05 22:23:00
p99
8.46 K
22:13:00
22:14:00
22:15:00
22:16:00
22:17:00
22:18:00
22:19:00
22:20:00
22:21:00
22:22:00
22:23:00
22:24:00
22:25:00
22:26:00
22:27:00
22:28:00
p50 (mean)
p90
p95
p99

Key Takeaways

1. Instrument early, instrument often

   There's no such thing as "too much data"

2. Beware high *cardinality*

   Aggregate, don't transact (that's what logs/traces are for)

3. Learn ye *PromQL*

   That's where the real leverage is

Lab time, again!

tomer@substrate.co.il

@tomerg

https://github.com/holograph/prometheus-workshop-service-python

Thank you for your attention

Questions?