

# OBSERVABILITY DATA ENGINEERING

A STORY ABOUT MATH, FOUR GOLDEN SIGNALS, AND BUSINESS INTELLIGENCE

---

Jack Neely

[jjneely@gmail.com](mailto:jjneely@gmail.com)

June 17, 2023

DevOps Observability Architect

*What do I monitor?*

Google SRE's ~~Four~~ Five Golden Signals

**Traffic** Counter of Units of Work

**Errors** Counter of Units of Work with Exceptions

**Latency** Timer of the distribution of latencies for each Unit of Work

**Saturation** When Pods be scaled up or down

**Health** Is the thing up? Does it respond to customers?

## AS A DEVOPS OBSERVABILITY ARCHITECT...

The ~~Four~~ Five Golden Signals is knowing before the customers do.

*We need to set alerts for these super special customers.*

Well, if we set our Histograms correctly and record maximum values we will be able to tell when...

*When a customer calls we need to be able to verify the error they encountered.  
We'll need a high cardinality solution.*

Umm...those aren't metrics. Where are your traces?

*Jack, we're an Enterprise!*

starship goes here

# TRAFFIC

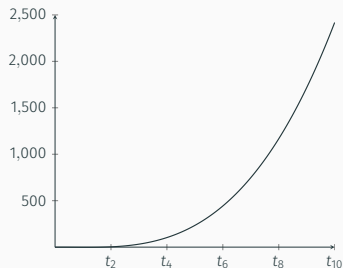
HOW TO COUNT THINGS

Systems based in cumulative monotonic sums are naturally simpler, in terms of the cost of adding reliability. When collection fails intermittently, gaps in the data are naturally averaged from cumulative measurements.

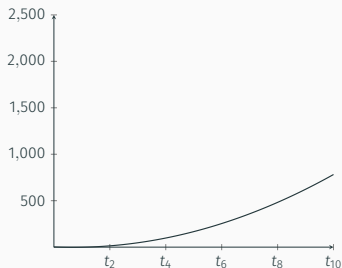
— OpenTelemetry Data Model Specification

- Accurate** Incremented in discrete whole numbers. Never misses an event.
- Synchronization** Primitive that allows for multiple observers.
- Low Overhead** Easy implementation. No copying or recalling previous values.
- Fundamental** Position at time  $t$ .

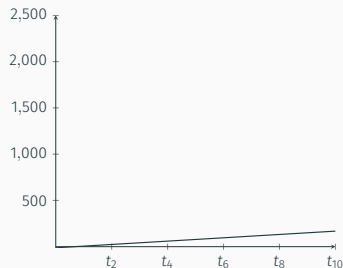
# REMEMBERING PHYSICS: FIRST AND SECOND DERIVATIVES



**Figure 1:** Position:  
`requests_total`

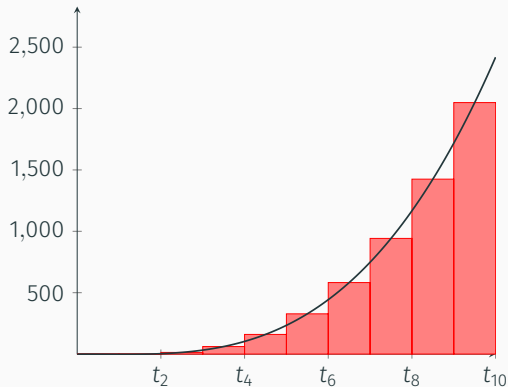


**Figure 2:** Velocity:  
`rate(requests_total[5m])`



**Figure 3:** Acceleration:  
`deriv(requests:rate5m[5m])`

# COUNTING CAVEATS: RIEMANN SUMS



```
interval: 5m
rules:
- record: labels:http_server_requests:rate5m
  expr: >
    sum by (service, namespace, status) (
      rate(http_server_requests_seconds_count{}[5m])
    )
```

## Integrate and Build Ratio:

```
1 - (
  sum_over_time(
    sum without (status) (
      labels:http_server_requests:rate5m{
        status=~"5..", service="..."})[7d:5m]
    ) * 300 /
  sum_over_time(
    sum without (status) (
      labels:http_server_requests:rate5m{
        service="..."})[7d:5m]
    ) * 300
  )
```



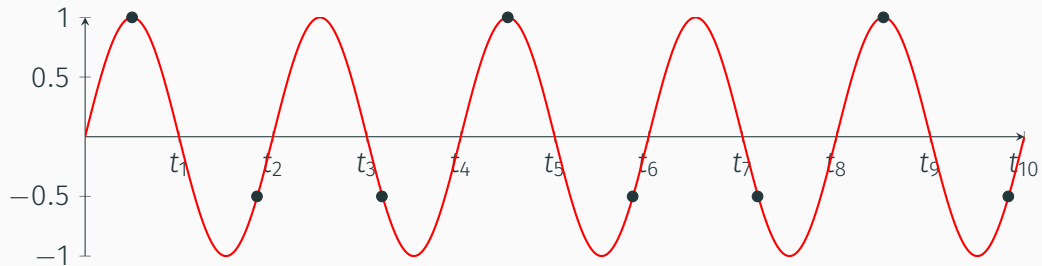
# ERRORS

YOUR CPU METRICS ARE WRONG AND I CAN PROVE IT

How do you measure CPU usage of a process?

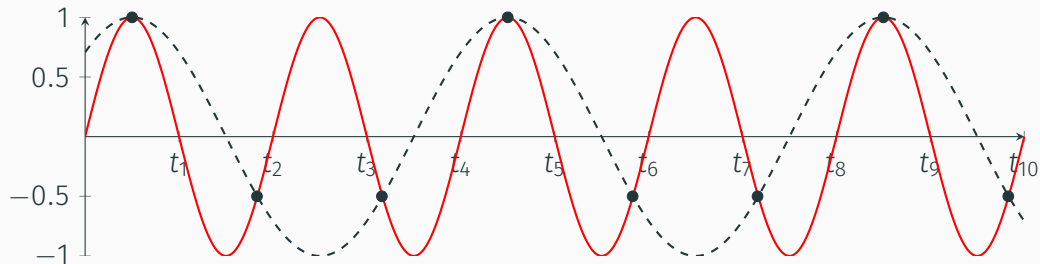
- a. Jiffies
- b. Percentages
- c. Seconds a Process is in the Running State
- d. All of the above

# NYQUIST-SHANNON SAMPLING THEOREM



*ScrapeInterval* >  $2f$

## NYQUIST-SHANNON SAMPLING THEOREM: ALIASING



*ScrapeInterval* >  $2f$

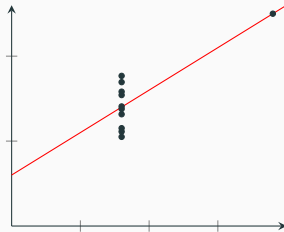
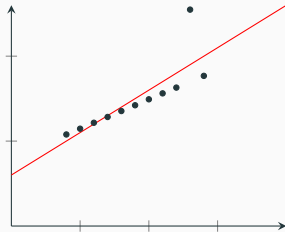
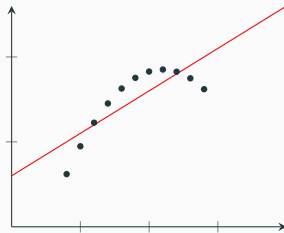
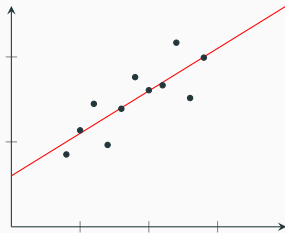
# LATENCY

AND OTHER NON-NORMAL DISTRIBUTIONS

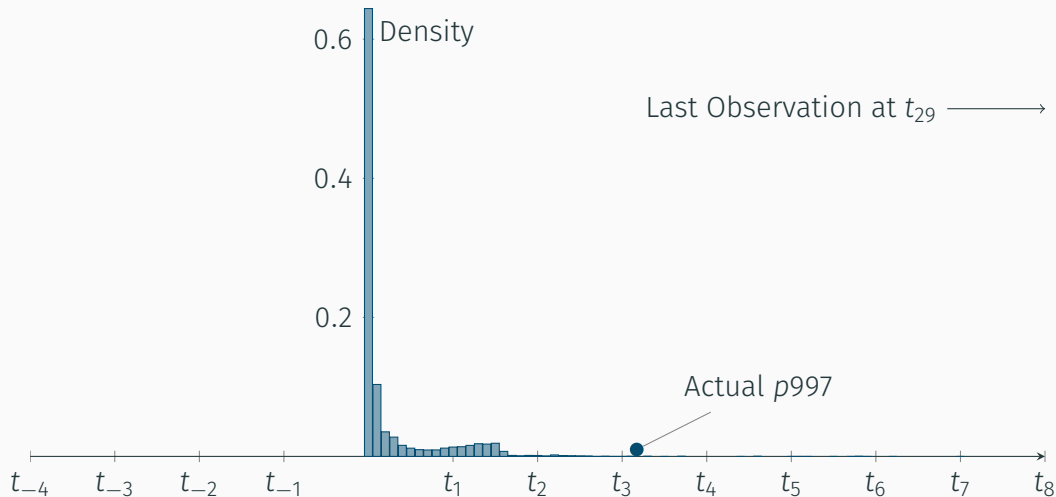
# ANSCOMB'S QUARTET

## Summary Statistics

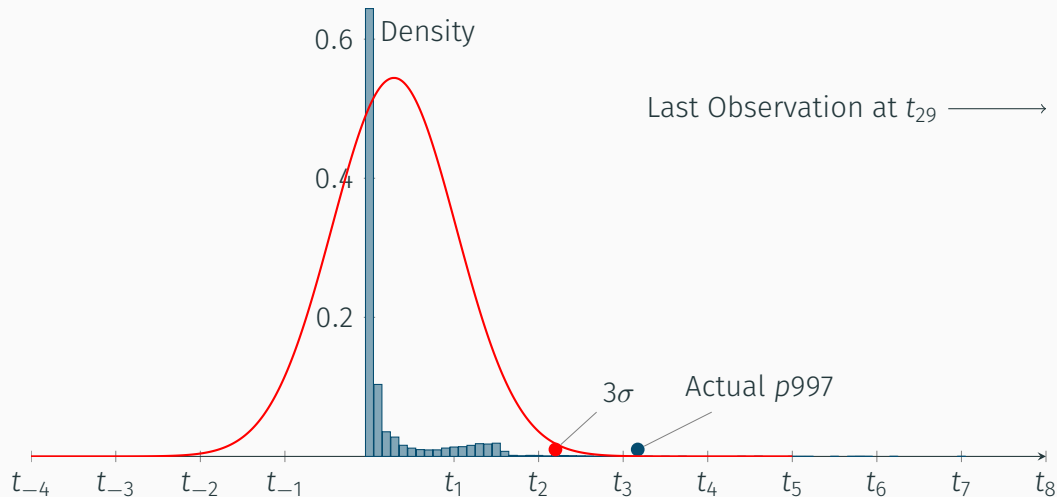
$N$	11
$\mu\{x_1..x_n\}$	9.0
$\mu\{y_1..y_n\}$	7.5
$\sigma\{x_1..x_n\}$	3.16
$\sigma\{y_1..y_n\}$	1.94
$r^2$	0.67



# NONSTANDARD DISTRIBUTIONS



# NONSTANDARD DISTRIBUTIONS





## STANDARD DISTRIBUTION CURVE FORMULA

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

$\sigma$  Standard Deviation

$\mu$  Mean

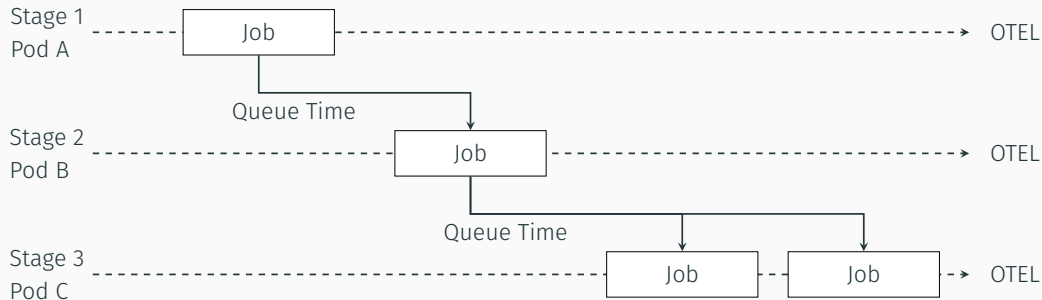
$e$  The base of Natural Logarithm and is about 2.71828

$\pi$  Pi! About 3.14159

# SATURATION

ARE WE SATURATED YET?

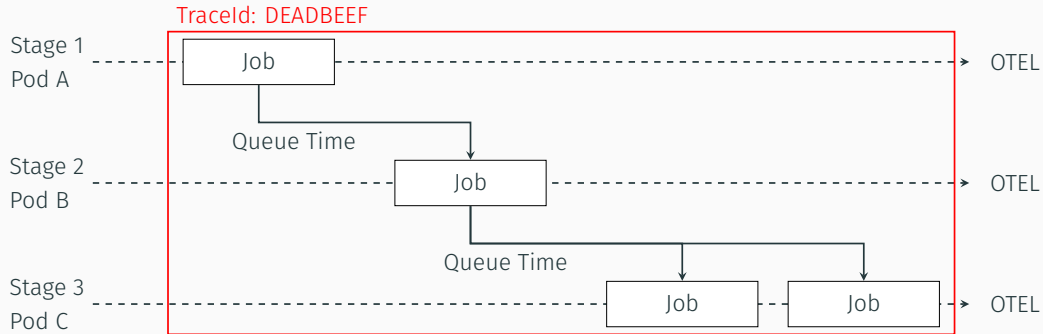
# TRACING PIPELINES



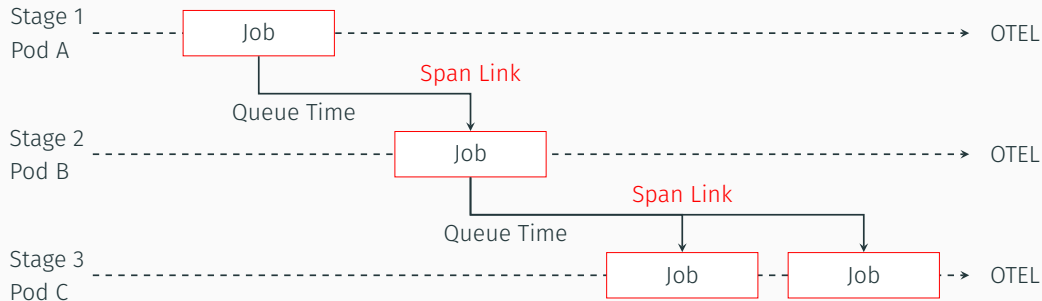
**Freshness SLO** X% of results are processed in Y time or less over the last Z days.

**Saturation SLO** X% of results have Y queue time or less over the last Z days.

# TRACING PIPELINES: HOW TO FAIL



## TRACING PIPELINES: USING SPAN LINKS



Create a Traceld per job and pass context across the bus. Child jobs create a Span Link to reference the Traceld of the parent pipeline job.

Build a schema and pass meta information along the bus.

```
{  
  foo=bar,  
  baz=sue  
}
```

# HEALTH

OF YOUR CUSTOMERS

**Goal:** Per Customer Median and Percentiles

**Problem:** High Velocity Log/Event Data

**Goal:** Summarize Per Customer Data Every 15 Minutes

**Problem:** Calculating 24 Hour (or longer) Percentiles from Rollups



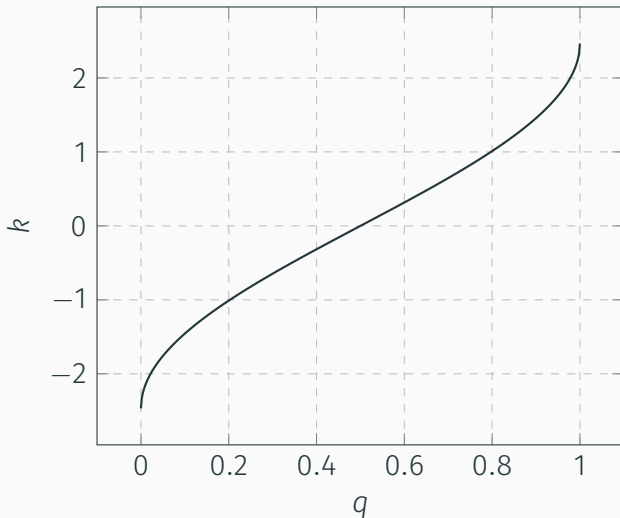
$$k(q) = \frac{\delta}{2\pi} \sin^{-1}(2q - 1)$$

$q$  Quantile (0 – 1 Inclusive)

$k$  Scale Factor

$\delta$  Compression Constant

$\pi$  Everybody run! It's  $\pi$  again!



## RESULTS 24 HOUR $q(.99)$ ESTIMATIONS FROM 15 MINUTE ROLLUPS

Overall  $q(.99)$  had a 2.32% Error

90% of Per Customer  $q(.99)$  had  $< 50\%$  Error



**Figure 4:** Example of High Error Customer Distribution

## KEY TAKEAWAYS

Question Averages

Use Quantiles to Represent Latency Spread

Median or  $q(0.50)$

$q(0.90)$

$q(0.95)$

$q(0.99)$

$3\sigma$  or  $q(0.997)$

Max or  $q(1)$