优步流处理应用

袁泳 @ UBER

UBER

优步简介

便捷交通，弹指之间


vodafone UK 3G
CANCEL
Westminster Underground Station
A302 Bridge St
Big Ben
VISA PERSONAL •••• 0134
CREDITS
FARE QUOTE
PROMO CODE
REQUEST UBERx

流数据 - 城市的脉搏

市场动态

当前全球有多少车可用

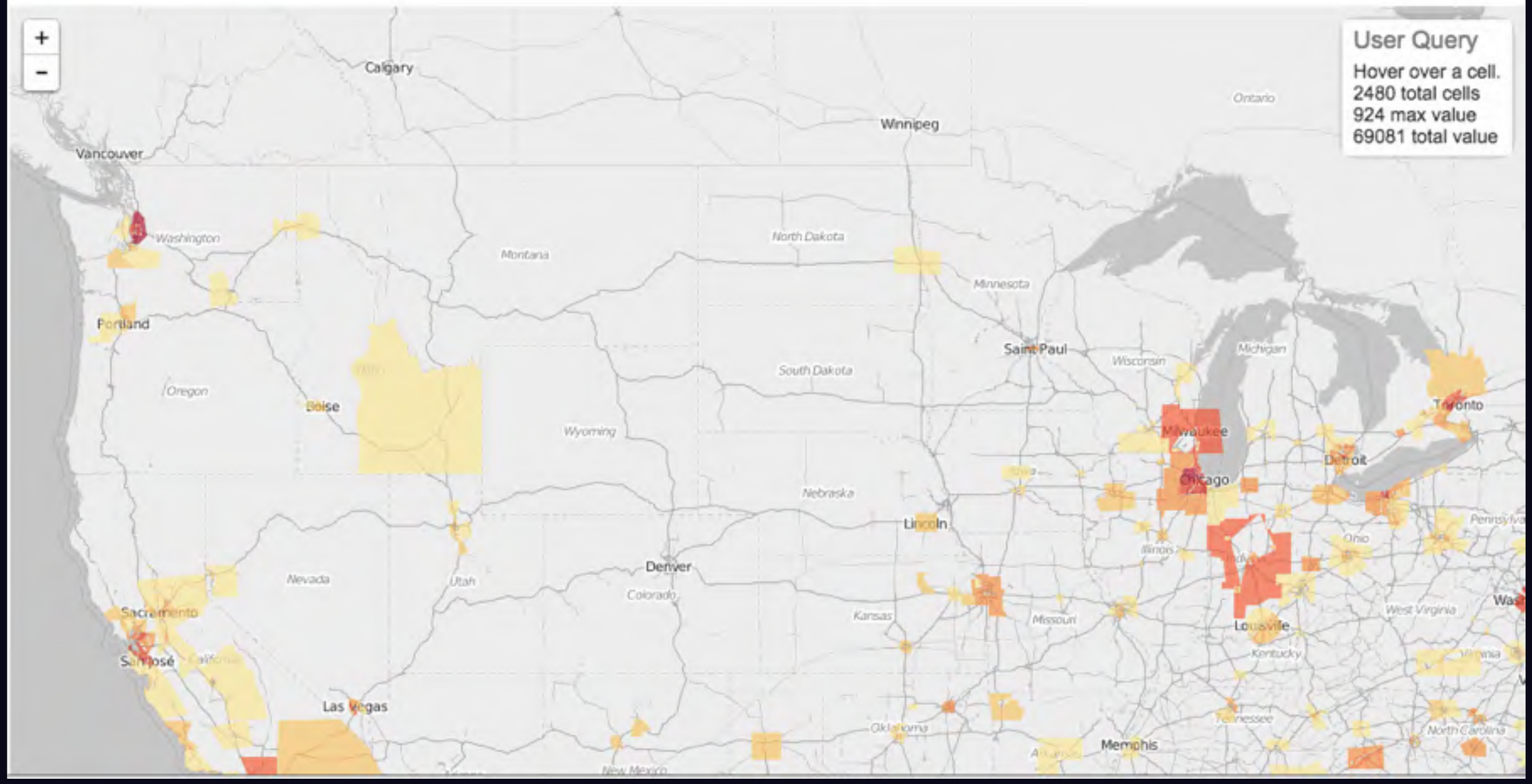
Query

Table | Heatmap | Stats

过去10分钟里旧金山里每个区域有多少车载客?

Query | Download as JSON | Download as CSV

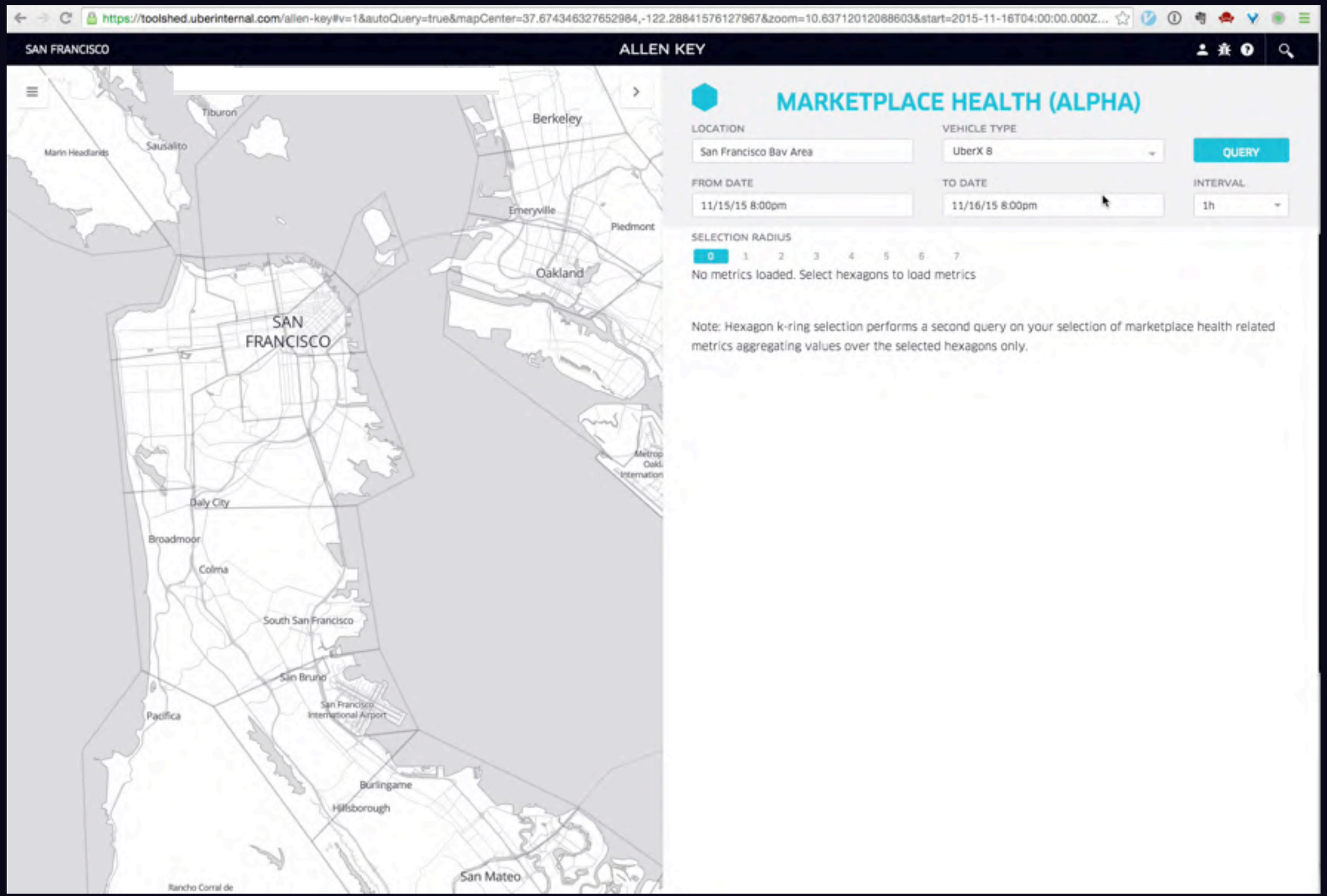
Table | Heatmap | Stats



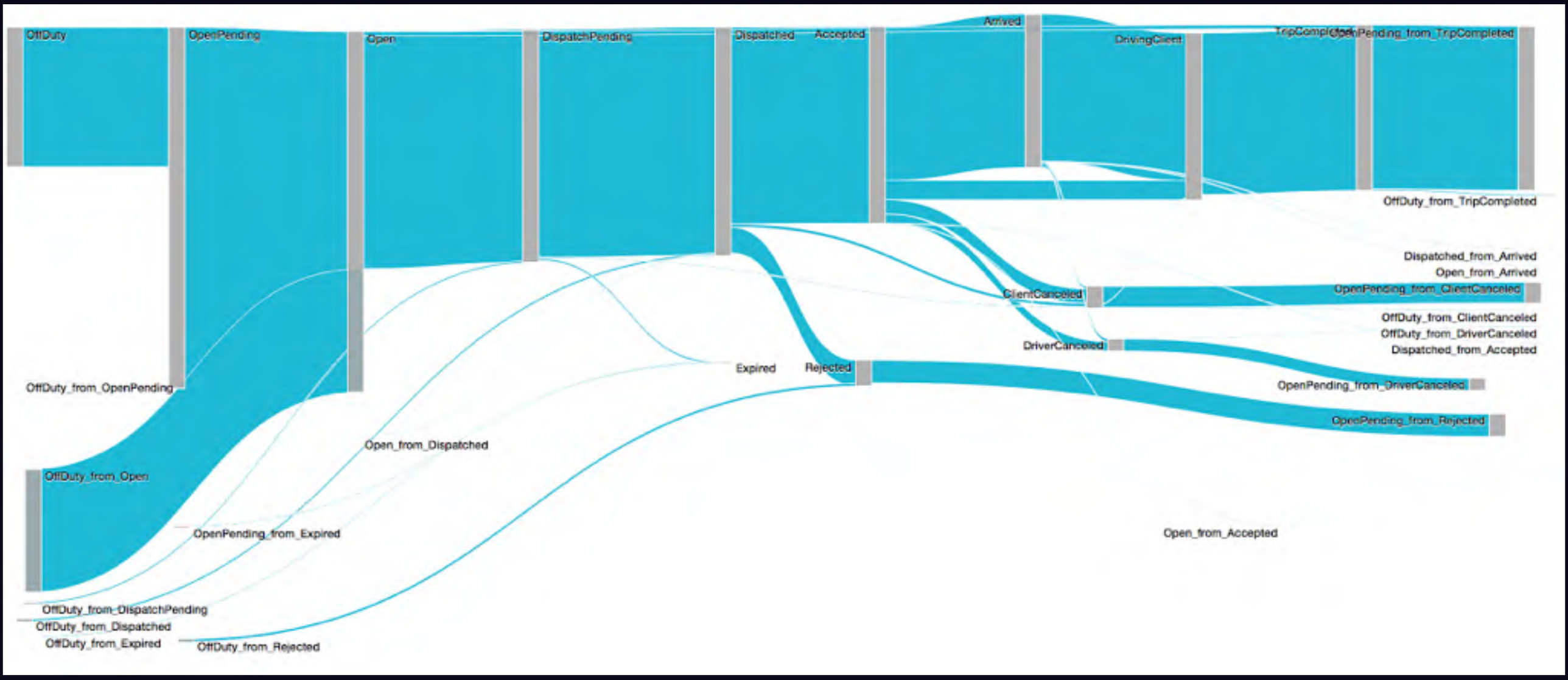
过去10分钟里旧金山里每个六边形有多少车载客?


Brentwood
Mill Valley
Walnut Creek
Tiburon
Berkeley
Orinda
Lafayette
Mount Diablo State Park
Moraga
Piedmont
Danville
Blackhawk
Oakland
SAN FRANCISCO
San Ramon
Mountain House
Tracy
San Leandro
Daly City
Dublin
Fairview
Livermore
Pleasanton
South San Francisco
San Bruno
Pacifica
Union City
Hillsborough
San Mateo
Moss Beach
Newark
El Granada
San Carlos
Redwood City
Your query is arriving now
0s
Half Moon Bay
Woodside
Milpitas
Moffett Federal Airfield
Norman Y. Mineta San Jose International Airport
Loyola Corners
San José
Campbell
Saratoga
Pescadero
Los Gatos

历史变化


https://toolshed.uberinternal.com/allen-key#v=1&autoQuery=true&mapCenter=37.674346327652984,-122.28841576127967&zoom=10.637120120886603&start=2015-11-16T04:00:00.000Z...
SAN FRANCISCO
ALLEN KEY
Tiburon
Berkeley
Marin Headlands
Sausalito
Emeryville
Piedmont
Oakland
SAN FRANCISCO
Daly City
Broadmoor
Colma
South San Francisco
San Bruno
San Francisco International Airport
Pacifica
Burlingame
Hillsborough
San Mateo
MARKETPLACE HEALTH (ALPHA)
LOCATION
San Francisco Bay Area
VEHICLE TYPE
UberX 8
QUERY
FROM DATE
11/15/15 8:00pm
TO DATE
11/16/15 8:00pm
INTERVAL
1h
SELECTION RADIUS
0 1 2 3 4 5 6 7
No metrics loaded. Select hexagons to load metrics
Note: Hexagon k-ring selection performs a second query on your selection of marketplace health related metrics aggregating values over the selected hexagons only.

状态跟踪


OffDuty
OpenPending
Open
DispatchPending
Dispatched
Accepted
Arrived
DrivingClient
TripCompleted
OpenPending_from_TripCompleted
OffDuty_from_TripCompleted
Dispatched_from_Arrived
Open_from_Arrived
OpenPending_from_ClientCancelec
OffDuty_from_ClientCanceled
OffDuty_from_DriverCanceled
Dispatched_from_Accepted
ClientCanceled
DriverCanceled
OpenPending_from_DriverCanceled
OpenPending_from_Rejected
Expired
Rejected
OffDuty_from_OpenPending
OffDuty_from_Open
Open_from_Dispatched
OpenPending_from_Expired
Open_from_Accepted
OffDuty_from_DispatchPending
OffDuty_from_Dispatched
OffDuty_from_Expired
OffDuty_from_Rejected

Dispatch Query Service

Driver States

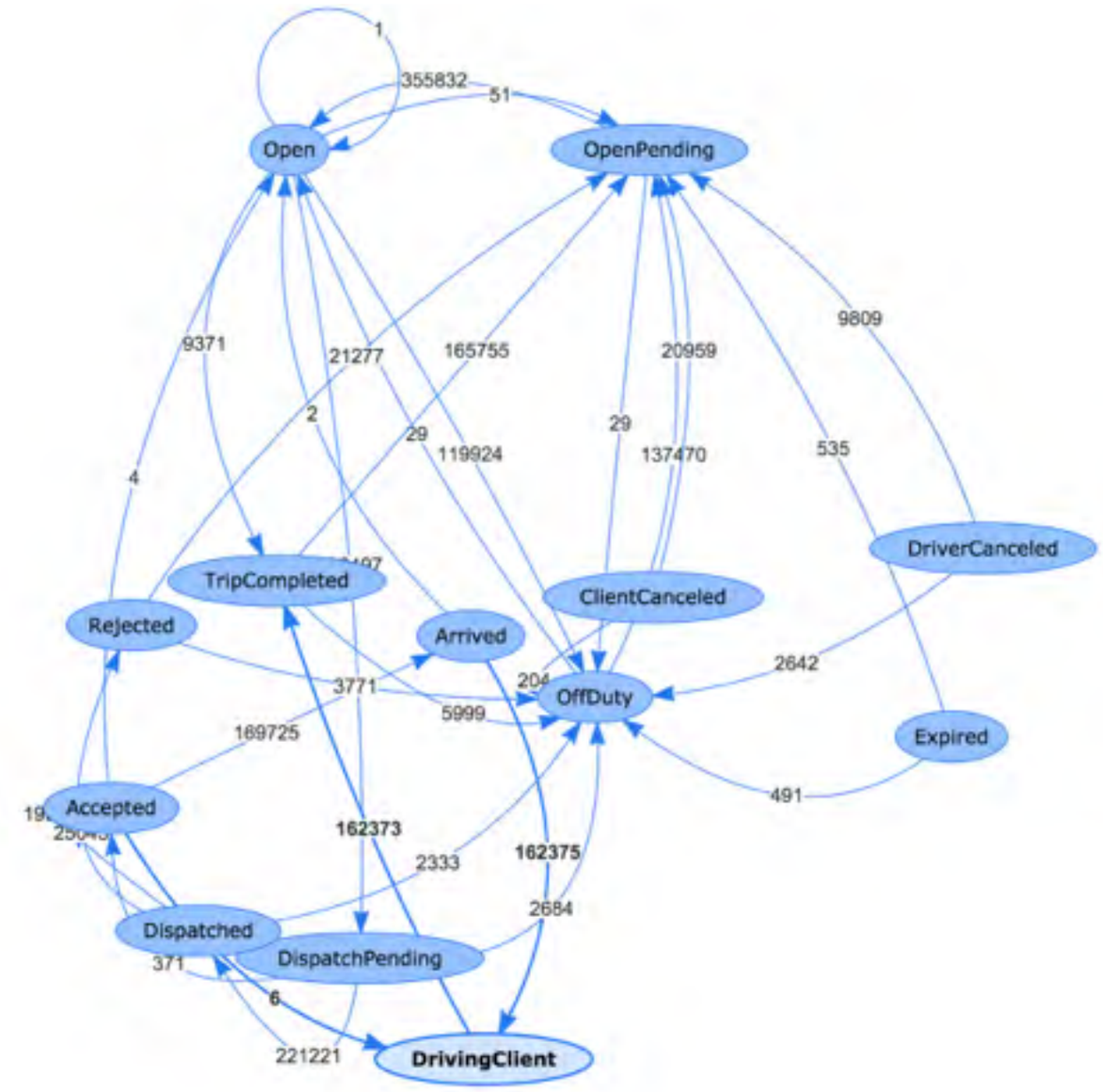
Choose a city

× San Francisco

Driver ID

Click to Query

Query



Dispatch Query Service

Driver States

Choose a city

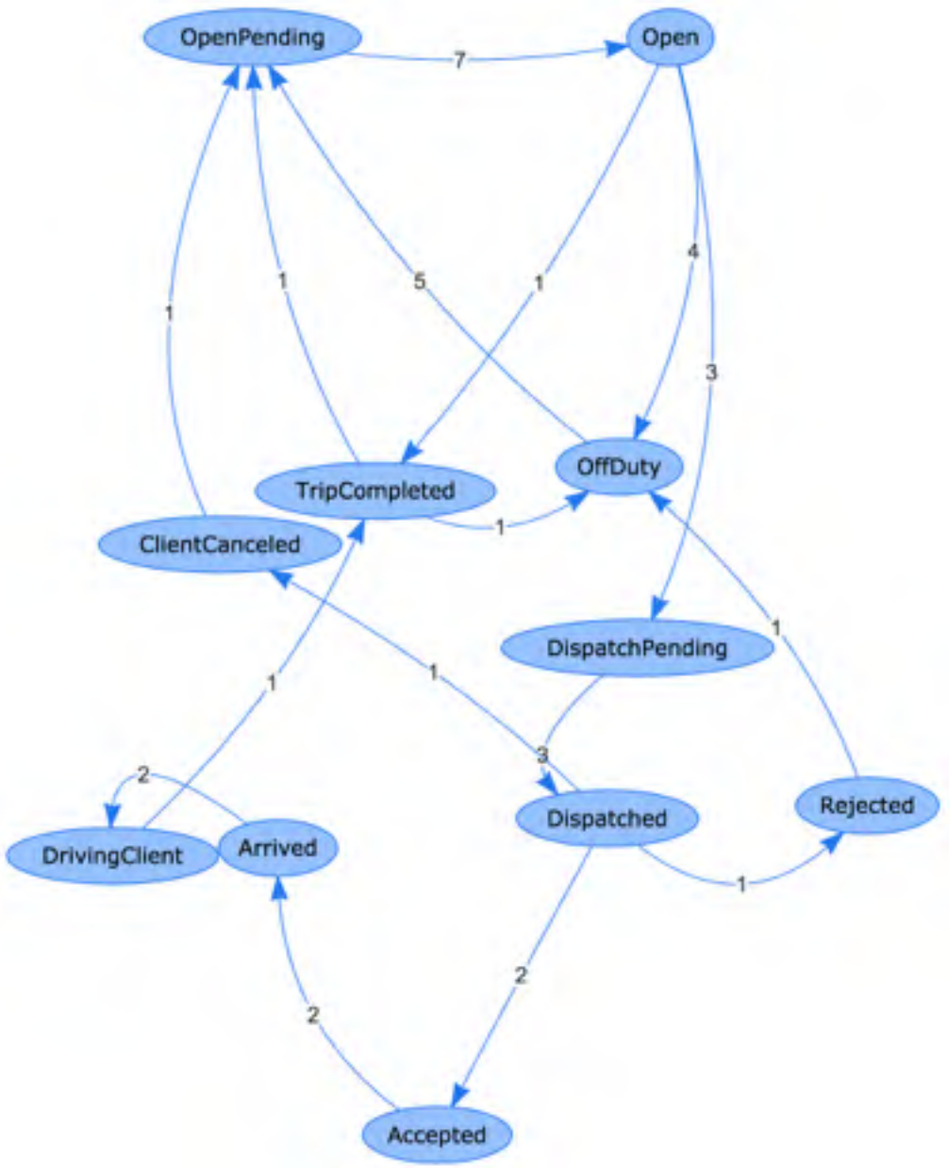
× San Francisco

Driver ID

1f2d9805-4d76-4a63-8

Click to Query

Query



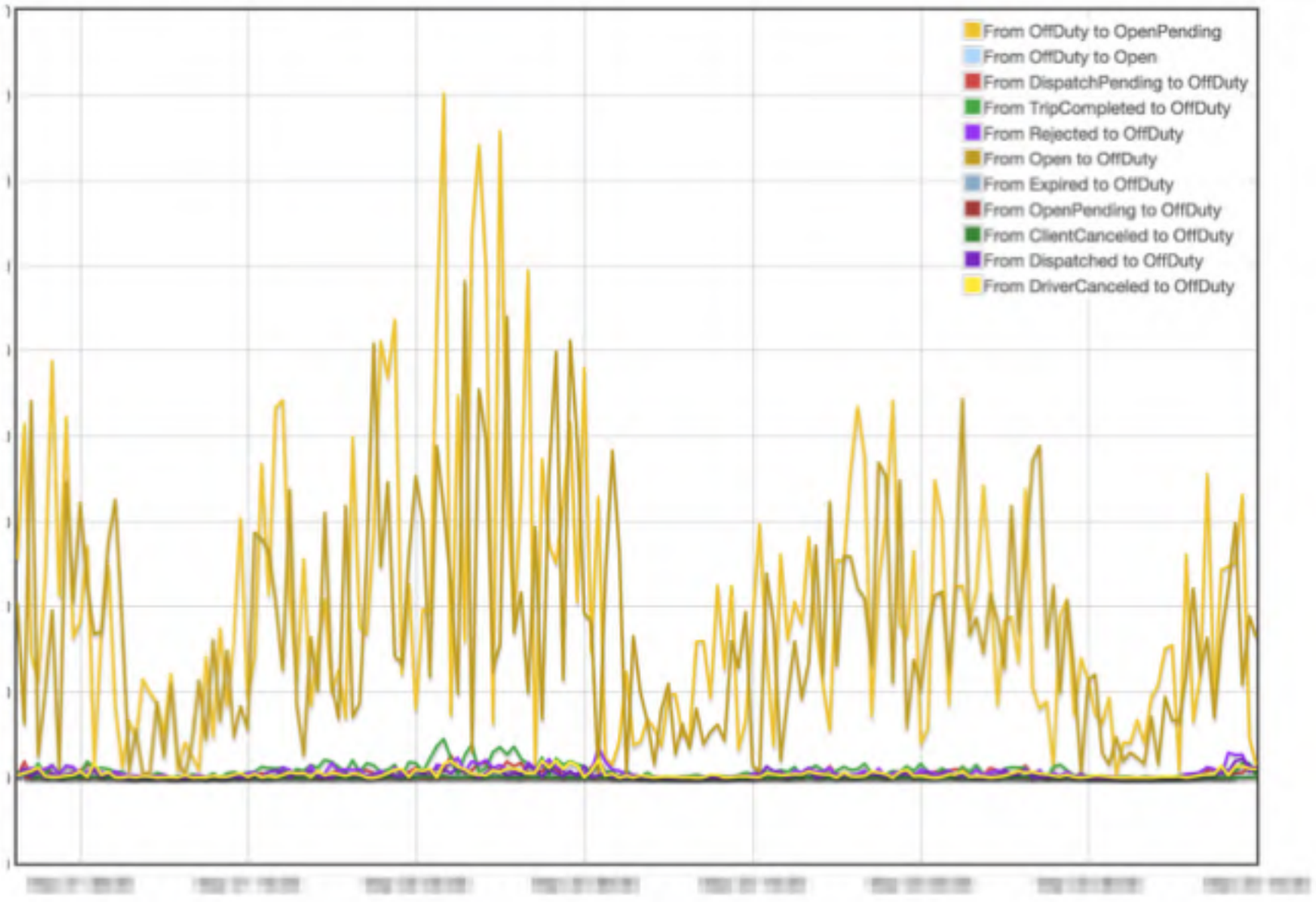
dispatch-qs.uber.com:9000/driver_status

Dispatch Query Service

59

Driver

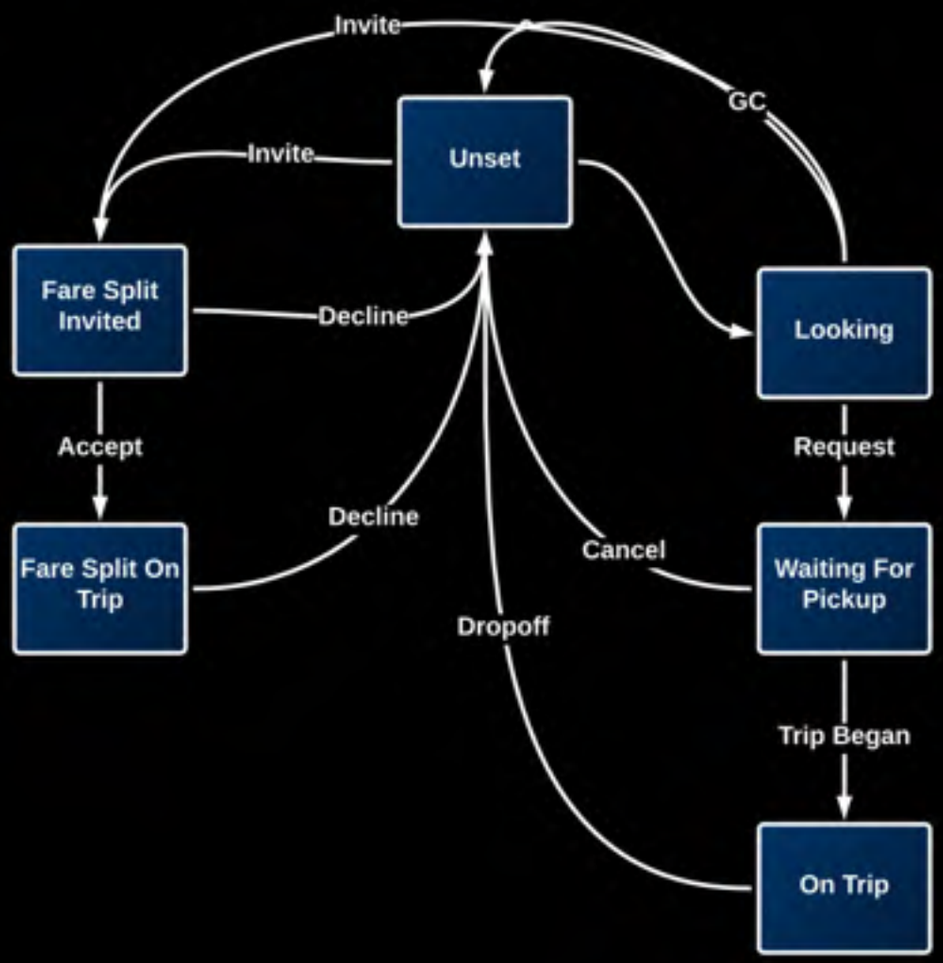
Count of State Change Over Time



出发点

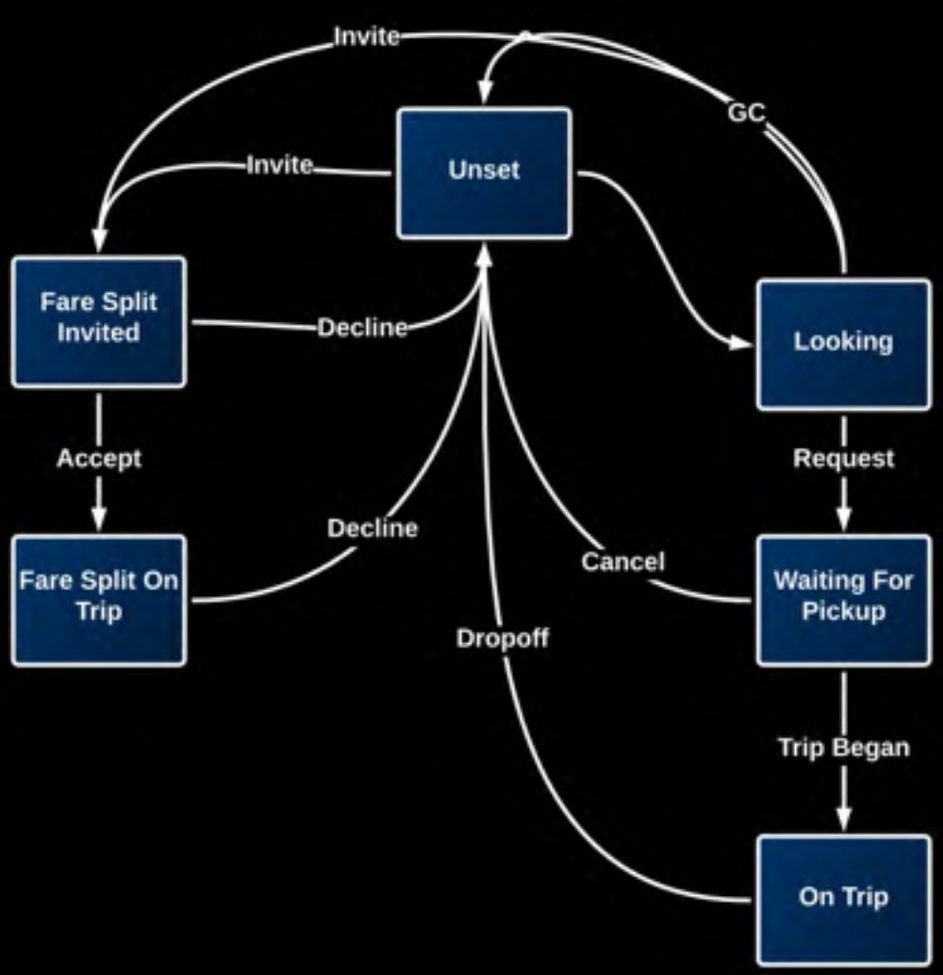
优步平台本质：分布式状态机

乘客状态

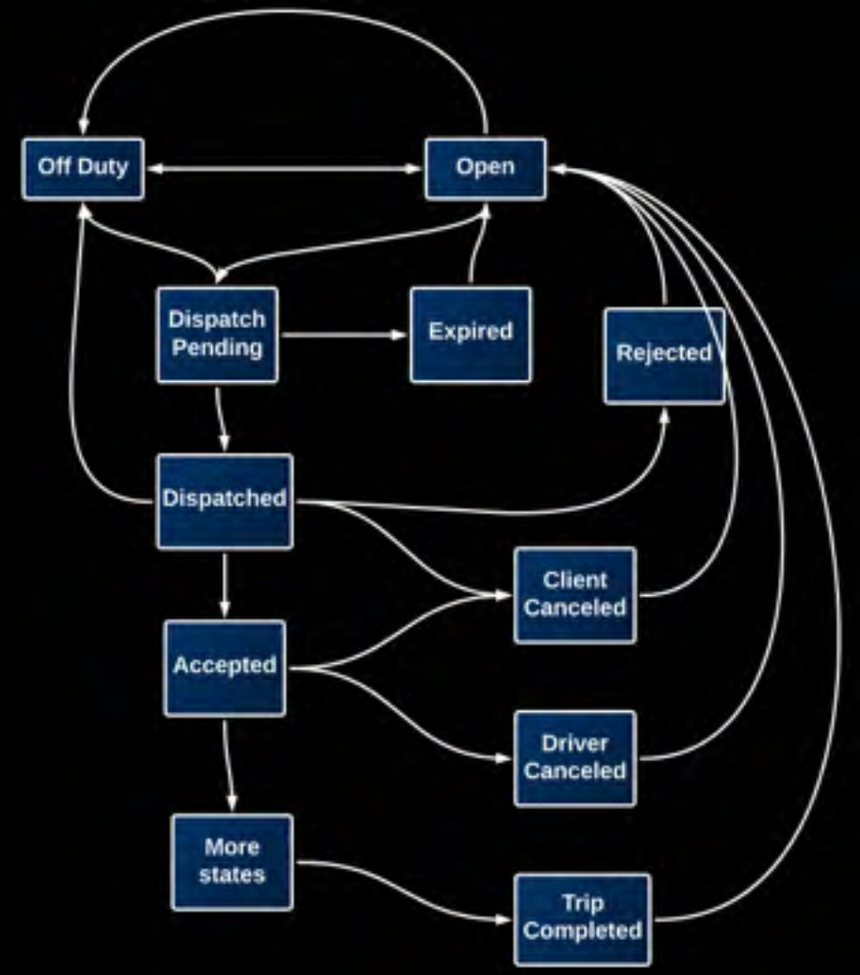


优步平台本质：分布式状态机

乘客状态



司机状态



各类应用生成事件

秒级事件延迟

事件绝少丢失

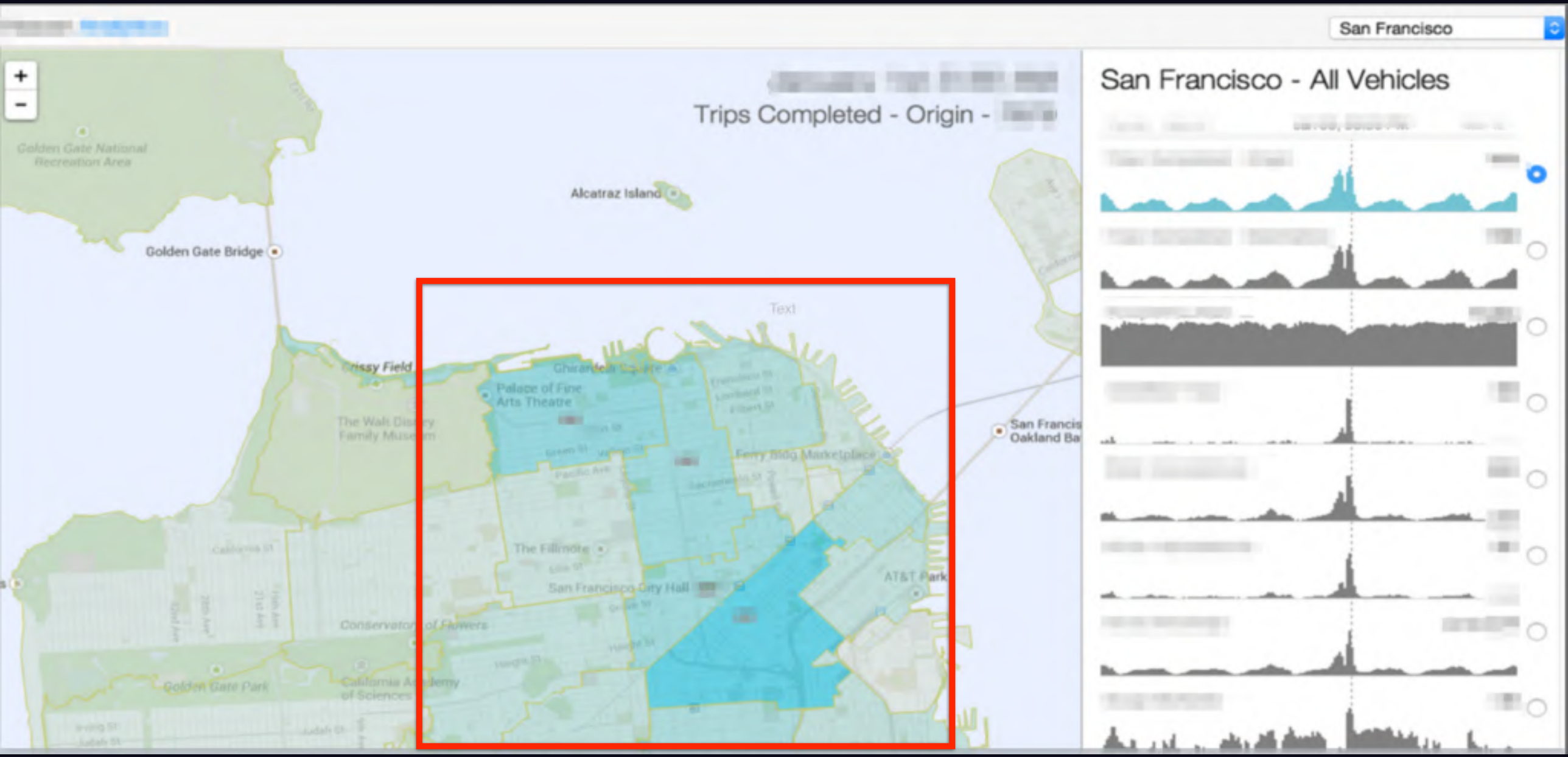
收集事件消息 - 低开销、易扩展

挑战在哪里?

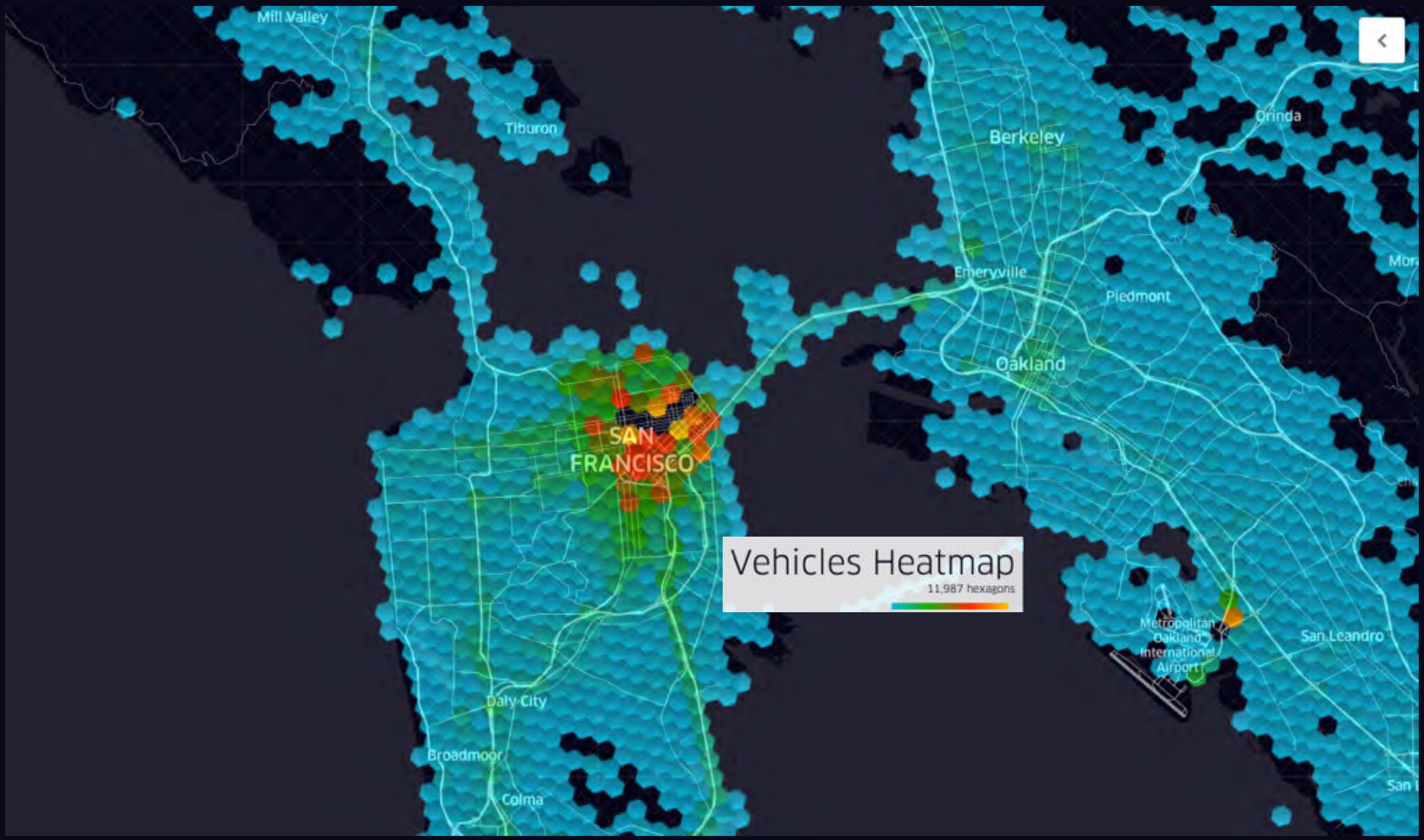
多维度

每个事件消息包含数十字段

细粒度数据

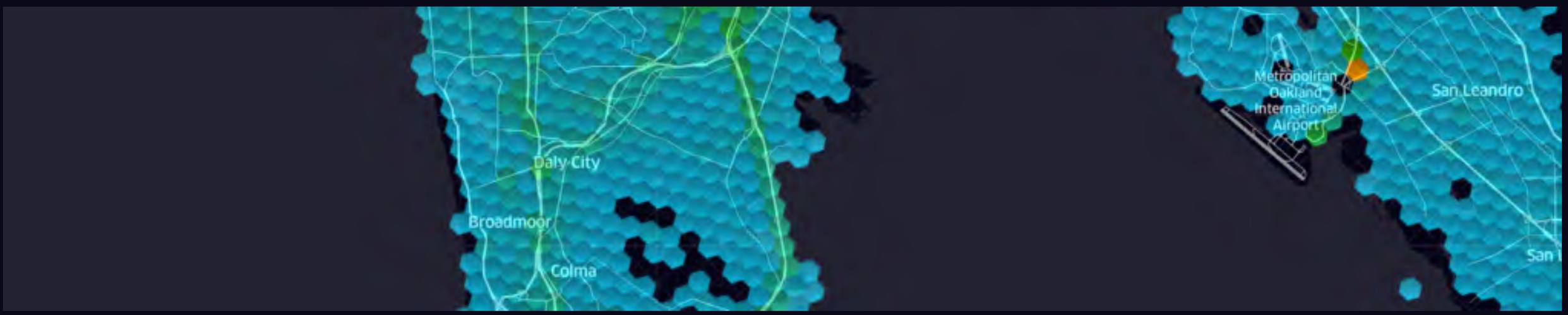

San Francisco
Trips Completed - Origin -
San Francisco - All Vehicles
Golden Gate National Recreation Area
Alcatraz Island
Golden Gate Bridge
Text
Palace of Fine Arts Theatre
The Walt Disney Family Museum
Ferry Bldg Marketplace
The Fillmore
San Francisco City Hall
AT&T Park
Conservatory of Flowers
Golden Gate Park
California Academy of Sciences
San Francis
Oakland Ba

细粒度数据


Mill Valley
Tiburon
Berkeley
Orinda
Emeryville
Piedmont
Oakland
SAN
FRANCISCO
Vehicles Heatmap
11,987 hexagons
Metropolitan
Oakland
International
Airport
San Leandro
Daly City
Broadmoor
Colma

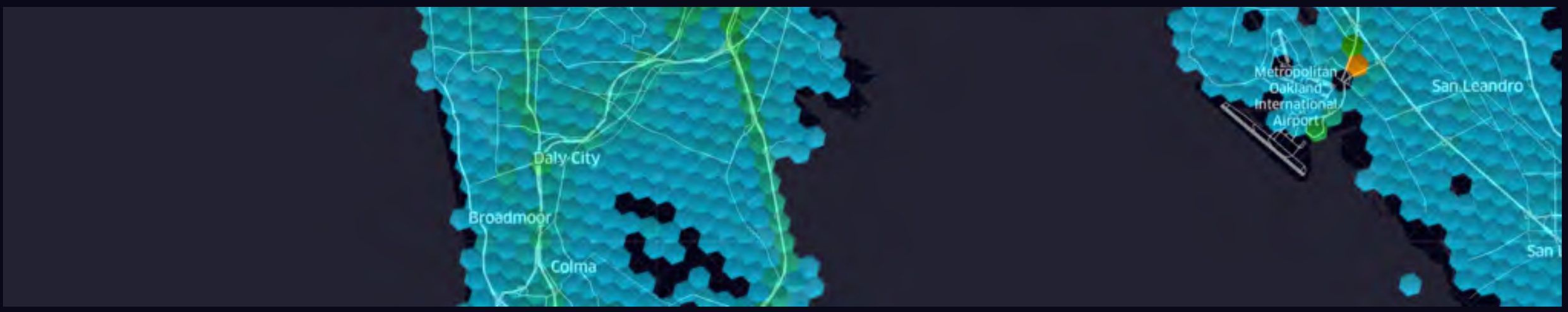
细粒度数据

每个城市多于 10,000 六边形



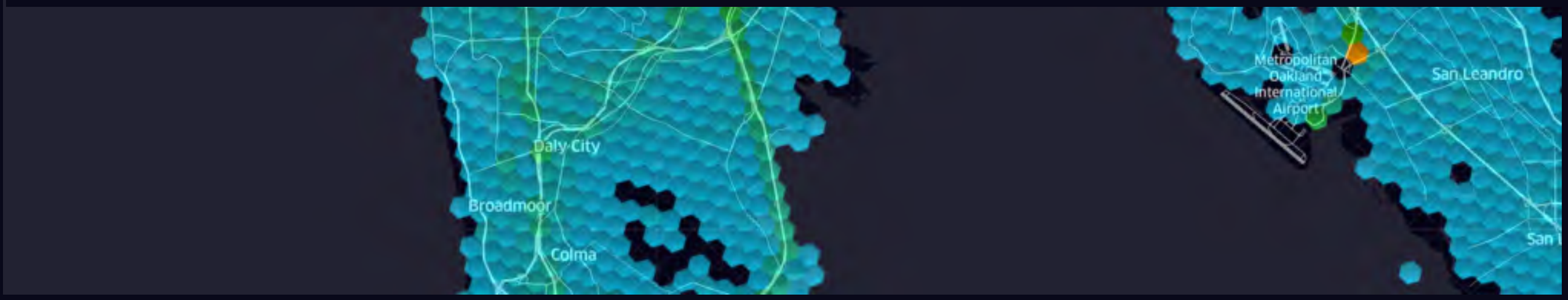
细粒度数据

7 种车型


Daly City
Broadmoor
Colma
Metropolitan
Oakland
International
Airport
San Leandro

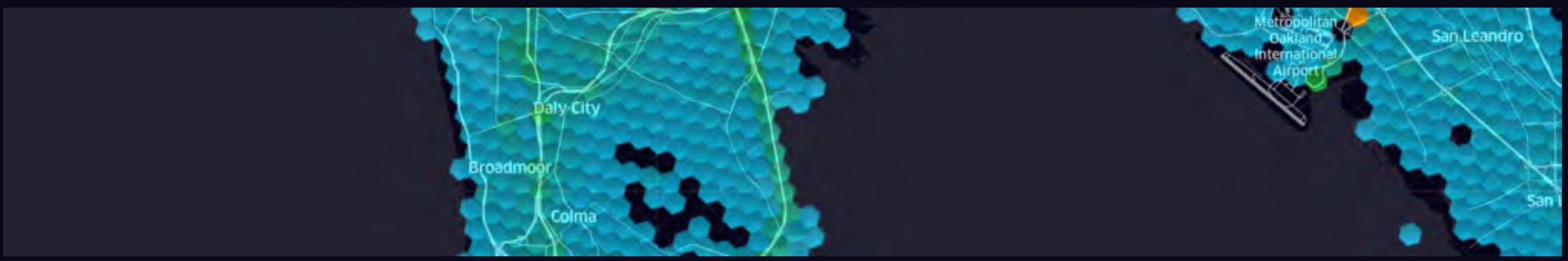
细粒度数据

一天1440分钟



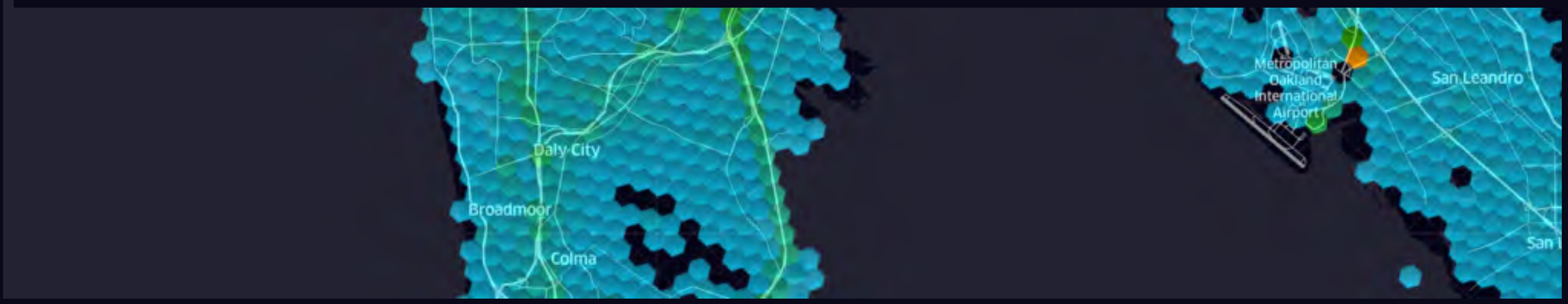
细粒度数据

13 种司机状态



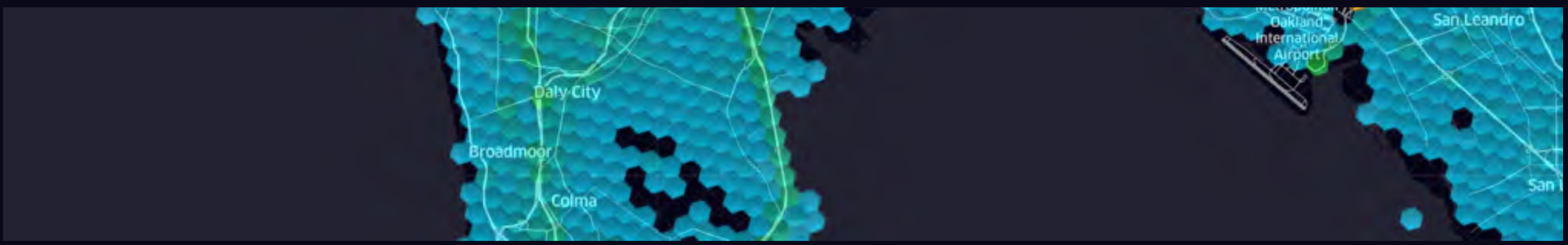
细粒度数据

300 座城市



细粒度数据

一天数据量:
300 x 10,000 x 7 x 1440 x 13 = 3930亿可能组合



查询模式不定

任意维度的组合

多种聚合查询

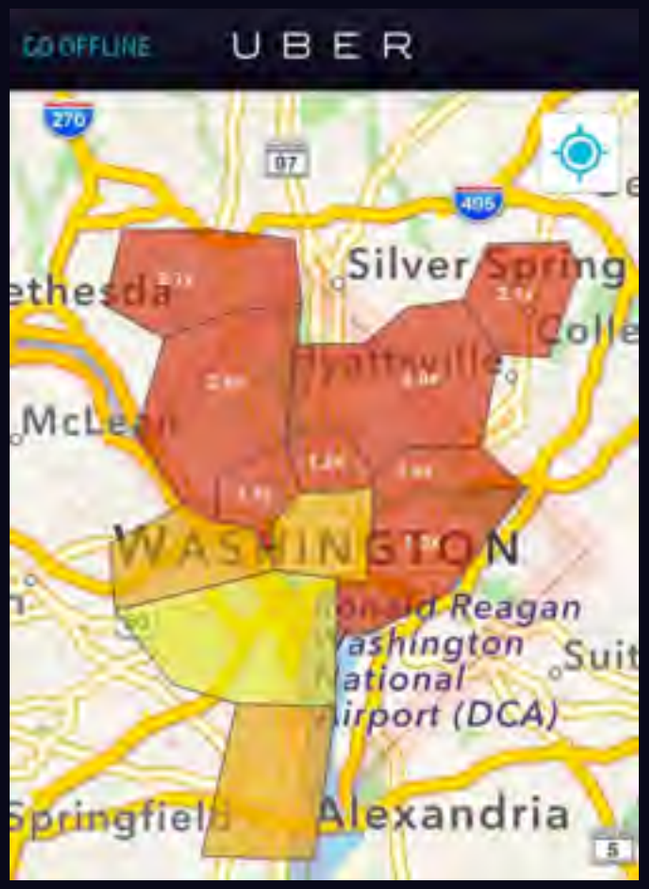
Heatmap

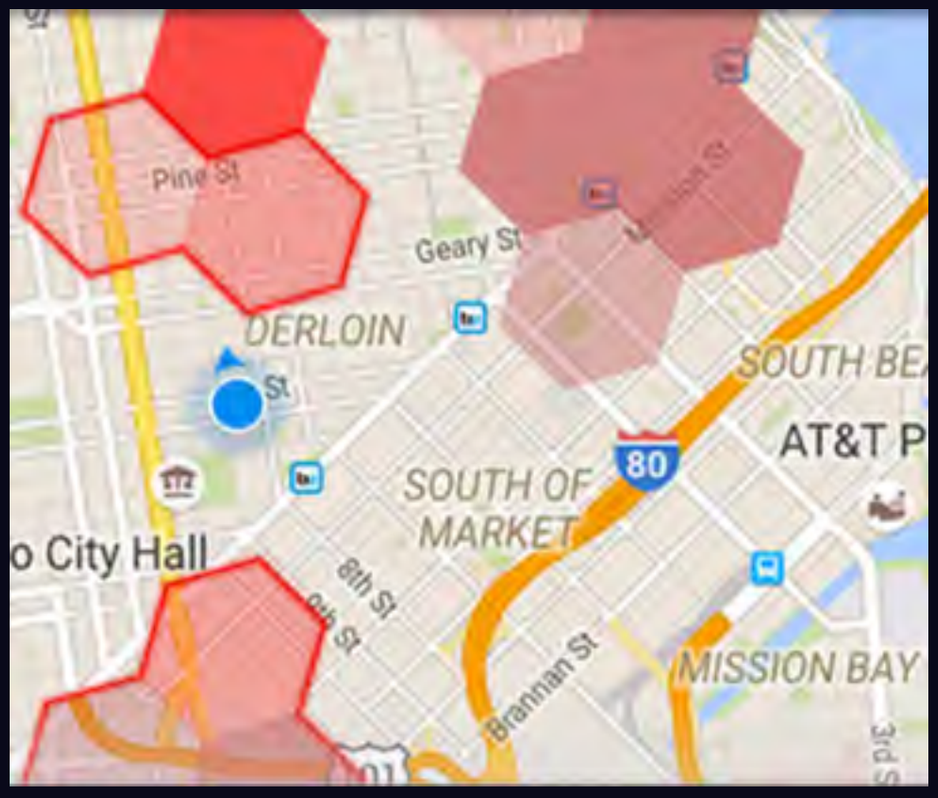
Top N

Histogram

count(), avg(), sum(), percent(), geo

多变的地理位置聚合查询





高流量

- 数十万条消息每秒，数百亿一天
- 每条消息包含数十字段

短时交货


Fast
Good
Cheap

关键: 把问题一般化

数据类型

- 多维时序数据

维度	值
state	driver_arrived
vehicle type	uber X
timestamp	13244323342
lattitude	12.23
longitude	30.00

数据查询

- 基于单表时空数据的OLAP

```
SELECT <agg functions>, <dimensions>
FROM <data_source>
WHERE <boolean filter>
GROUP BY <dimensions>
HAVING <boolean filter>
ORDER BY <sorting criterial>
LIMIT <n>
DO <post aggregation>
```

选择存储系统

最低要求

- 支持时序和地理空间的OLAP
- 支持大流量数据
- 支持秒级查询
- 支持原始数据查询

键值数据库

键值数据库

一键一值：预算所有组合

维度	值
A	a
B	b

一键一值：预算所有组合

维度	值
A	a
B	b

- 布尔操作符: AND, OR, NOT

一键一值：预算所有组合

维度	值
A	a
B	b

- 布尔操作符: AND, OR, NOT
  - A and (not B)
  - B and (not A)
  - A or B
  - not (A or B)

一键一值：预算所有组合

维度
A
B

- {A}
- {B}
- {A, B}
- {}

一键一值：预算所有组合

维度
A
B

- {A}
- {B}
- {A, B}
- {}

⟶ 计算幂集

键值数据库的局限

预算所有键值组合的时空复杂度：$O(2^n)$

关系数据库

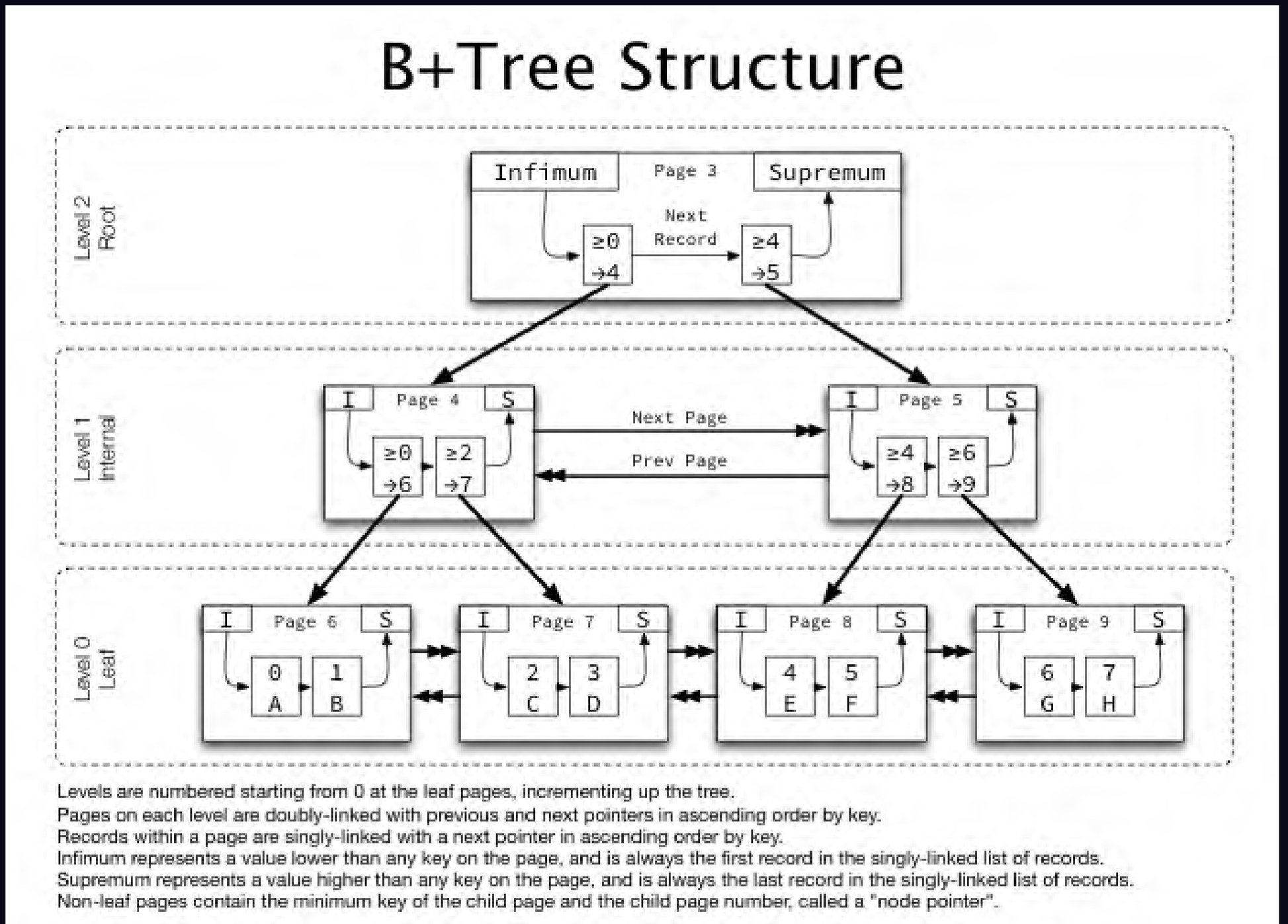
~~关系数据库~~

关系数据库的局限

- 不易管理多项索引

关系数据库的局限

- 扫描速度不够



但我的KV系统速度奇快

光快不行

一个城市里每个六边形里车的数目 => 18,000 次查询

平均延迟: 1ms

99.99百分位延迟: 2s

失败率: 0.001%

光快不行

一次查询延迟超过99.99百分位的概率: $(1 - 0.9999^{18000})$ x = 83%

一次查询成功的概率: $(1 - 0.00001)^{18000}$ = 84%

系统必备功能

- 快速扫描
- 布尔查询
- 原始数据
- 各类聚合

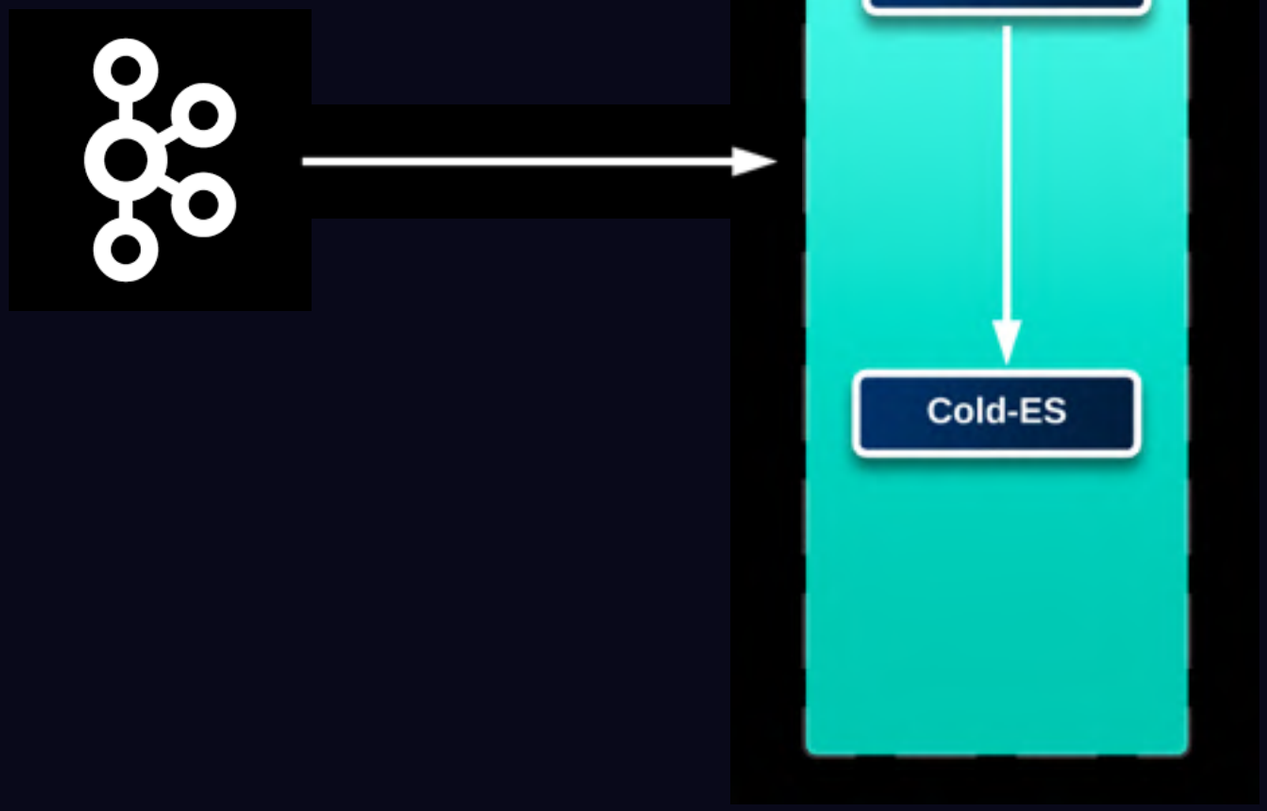
Elasticsearch

基于高效倒排索引的布尔查询

内建分布式查询

快速扫描，灵活聚合

存储

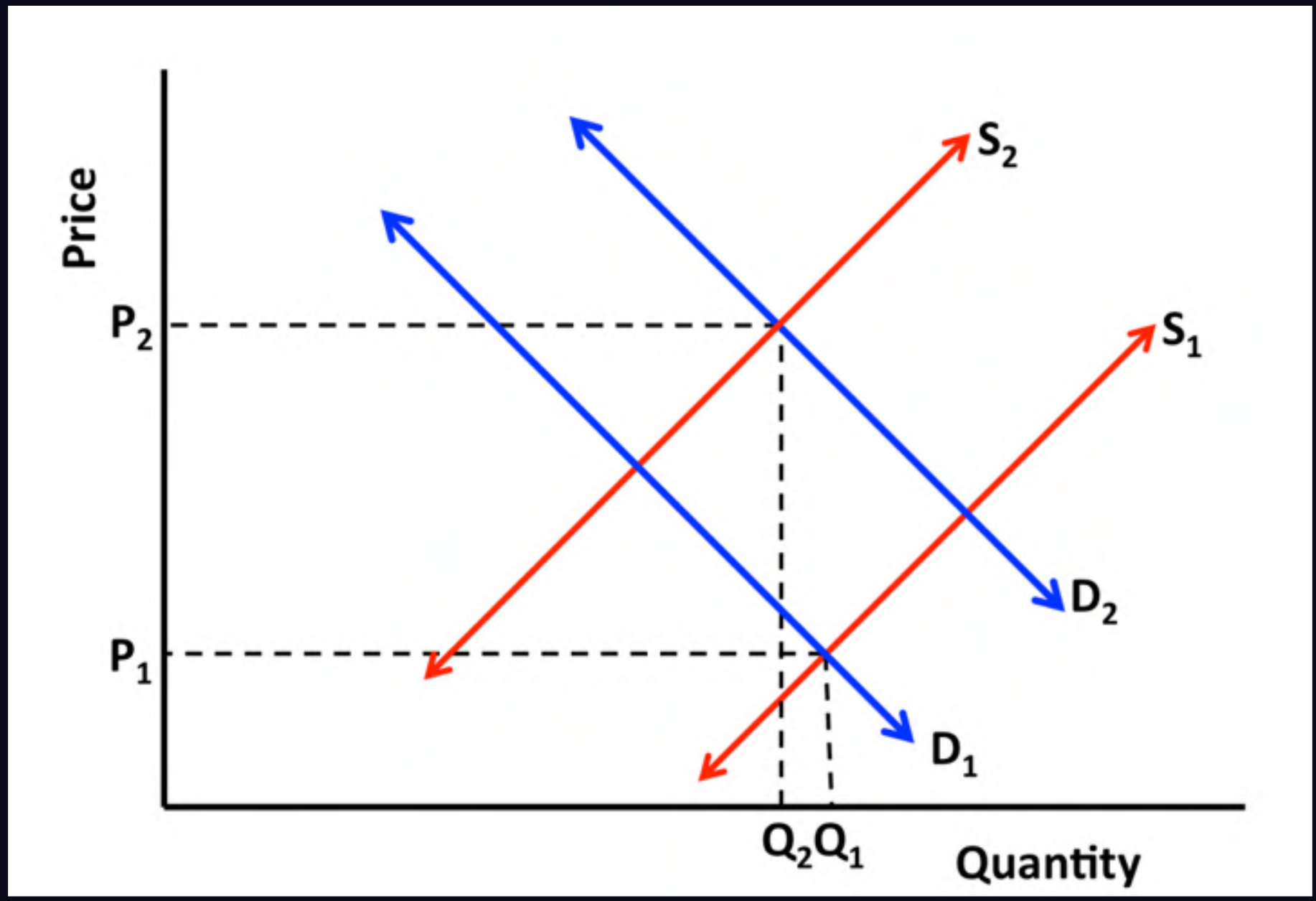


搞定没?

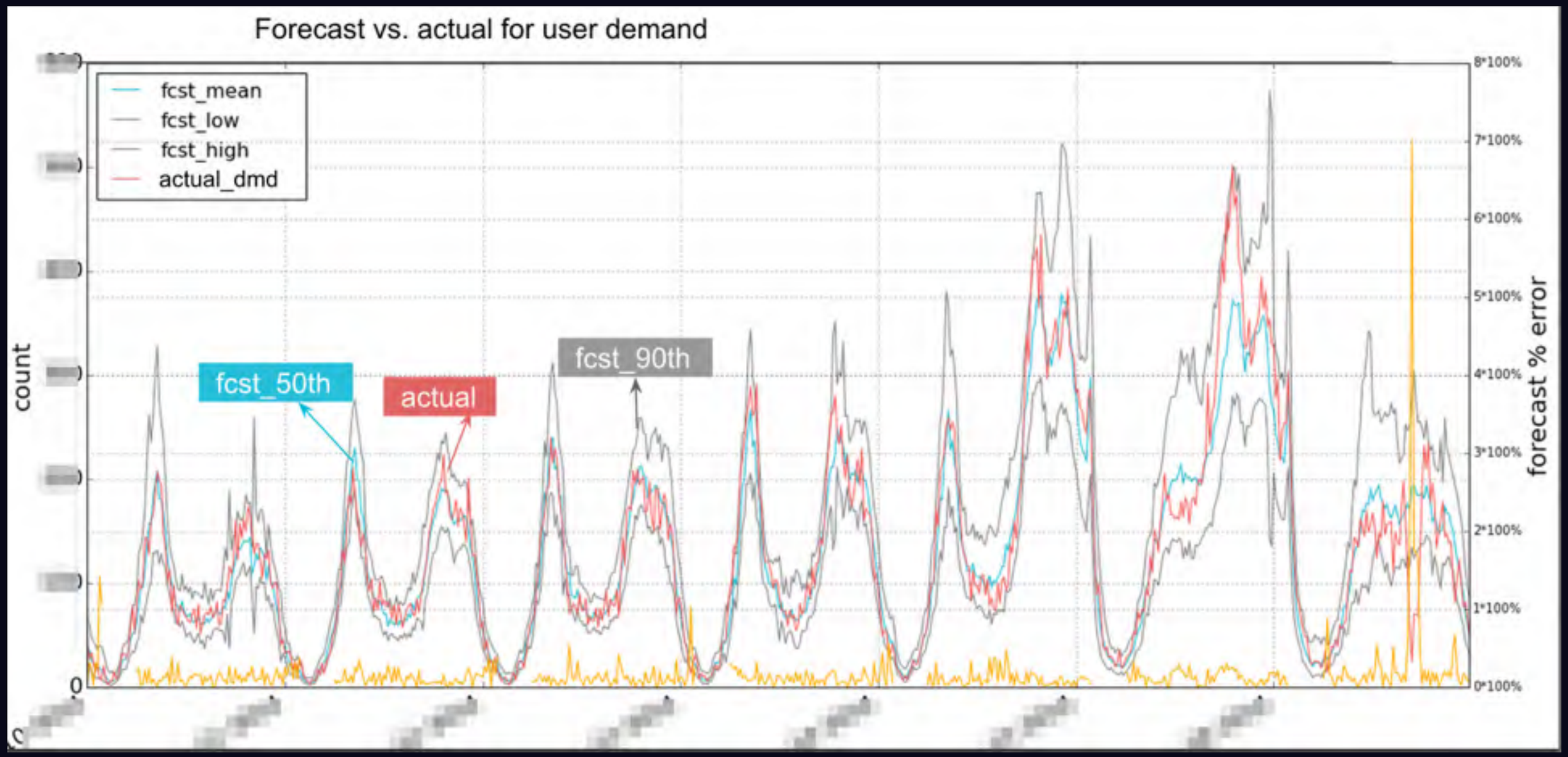
数据转换

e.g. (Lat, Long) -> (zipcode, hexagon)

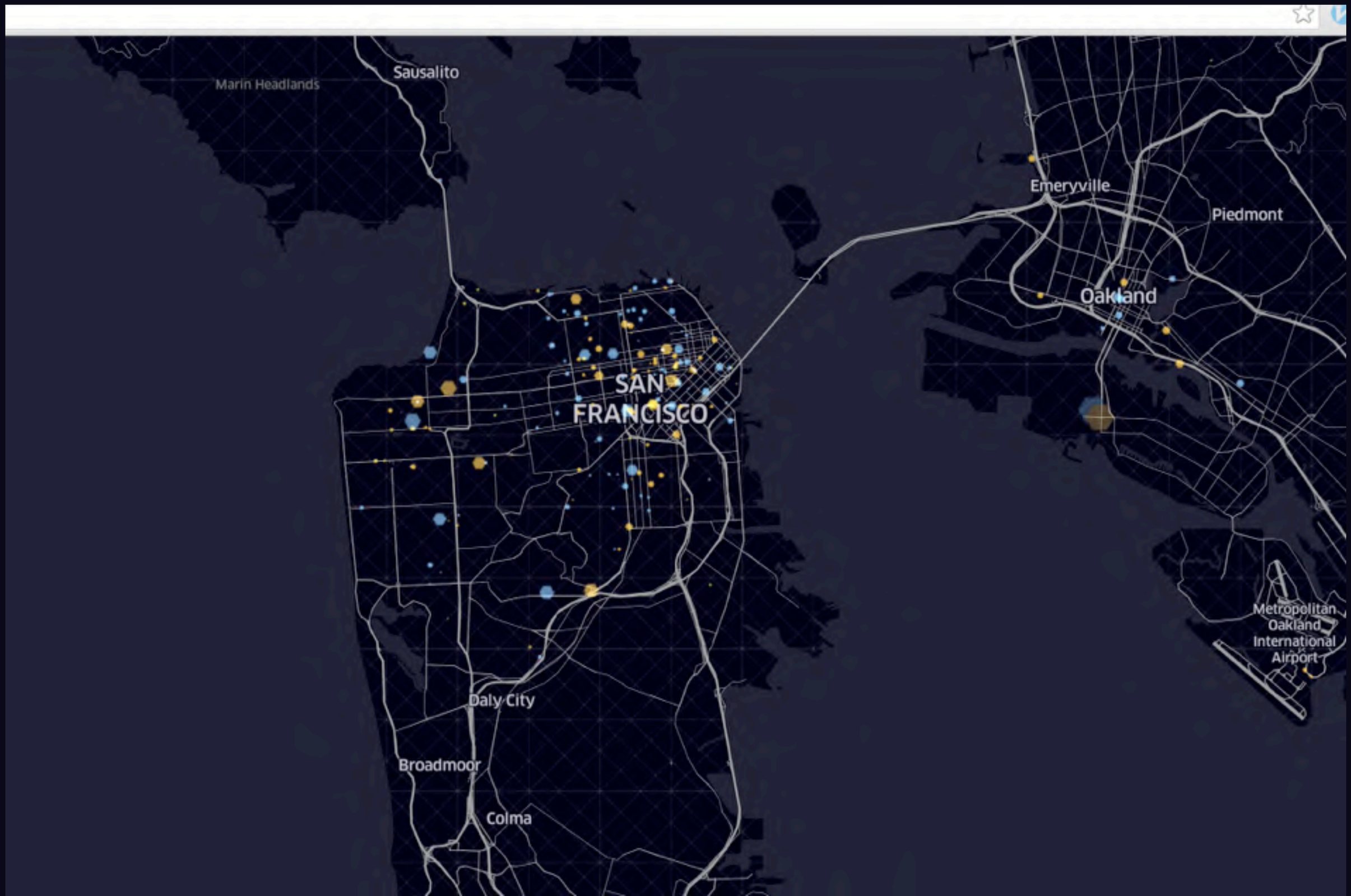
动态定价



趋势预测


Forecast vs. actual for user demand
fcst_mean
fcst_low
fcst_high
actual_dmd
fcst_50th
actual
fcst_90th
count
forecast % error
8*100%
7*100%
6*100%
5*100%
4*100%
3*100%
2*100%
1*100%
0*100%
0

供求分布


Marin Headlands
Sausalito
Emeryville
Piedmont
Oakland
SAN
FRANCISCO
Metropolitan
Oakland
International
Airport
Daly City
Broadmoor
Colma

技术上说: Clustering & Pr(D, S, E)

新场景 —> 新需求

预处理

Joining Multiple Streams

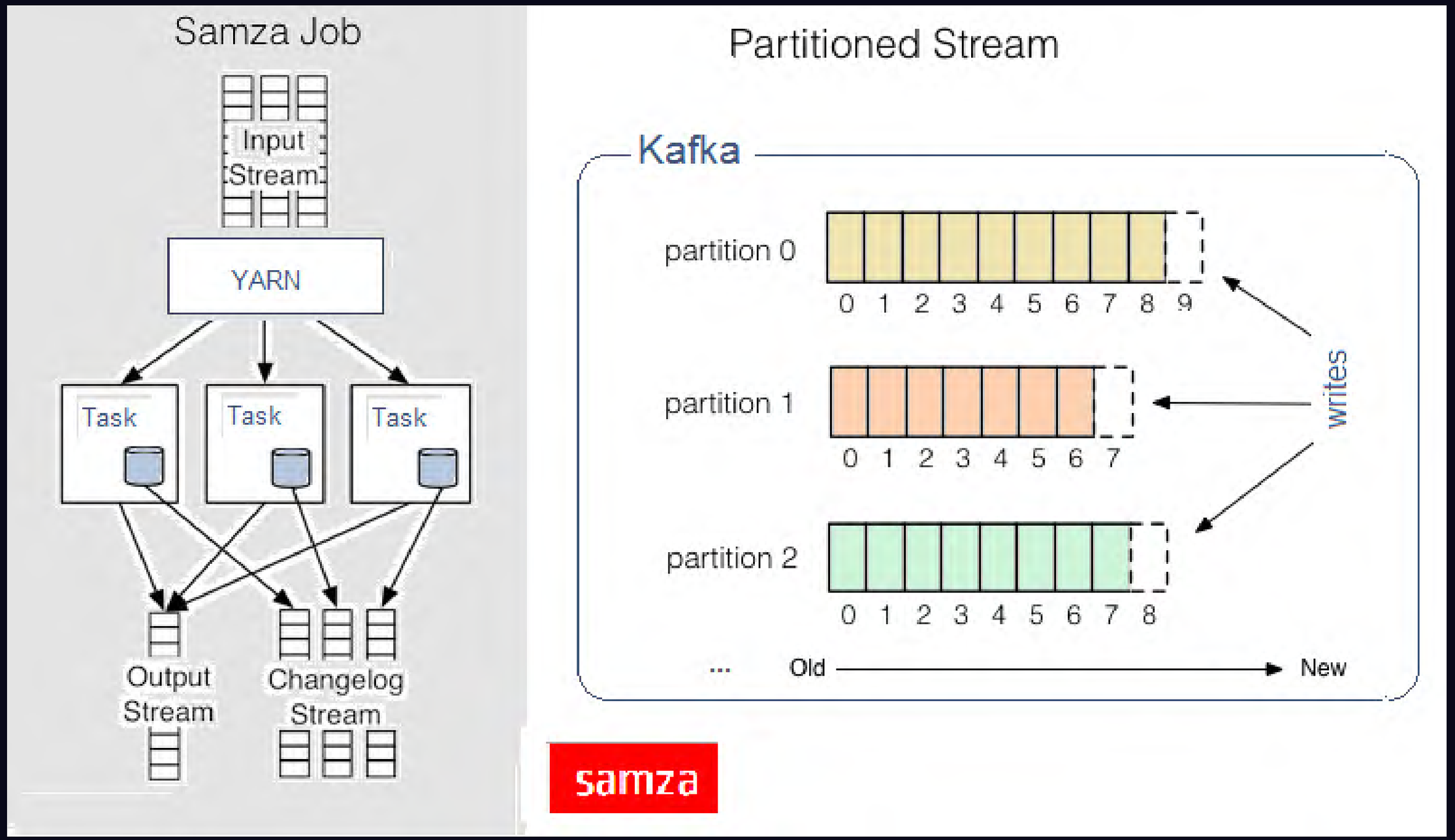
Sessionization

多级处理

状态管理

Apache Samza

Why Apache Samza?

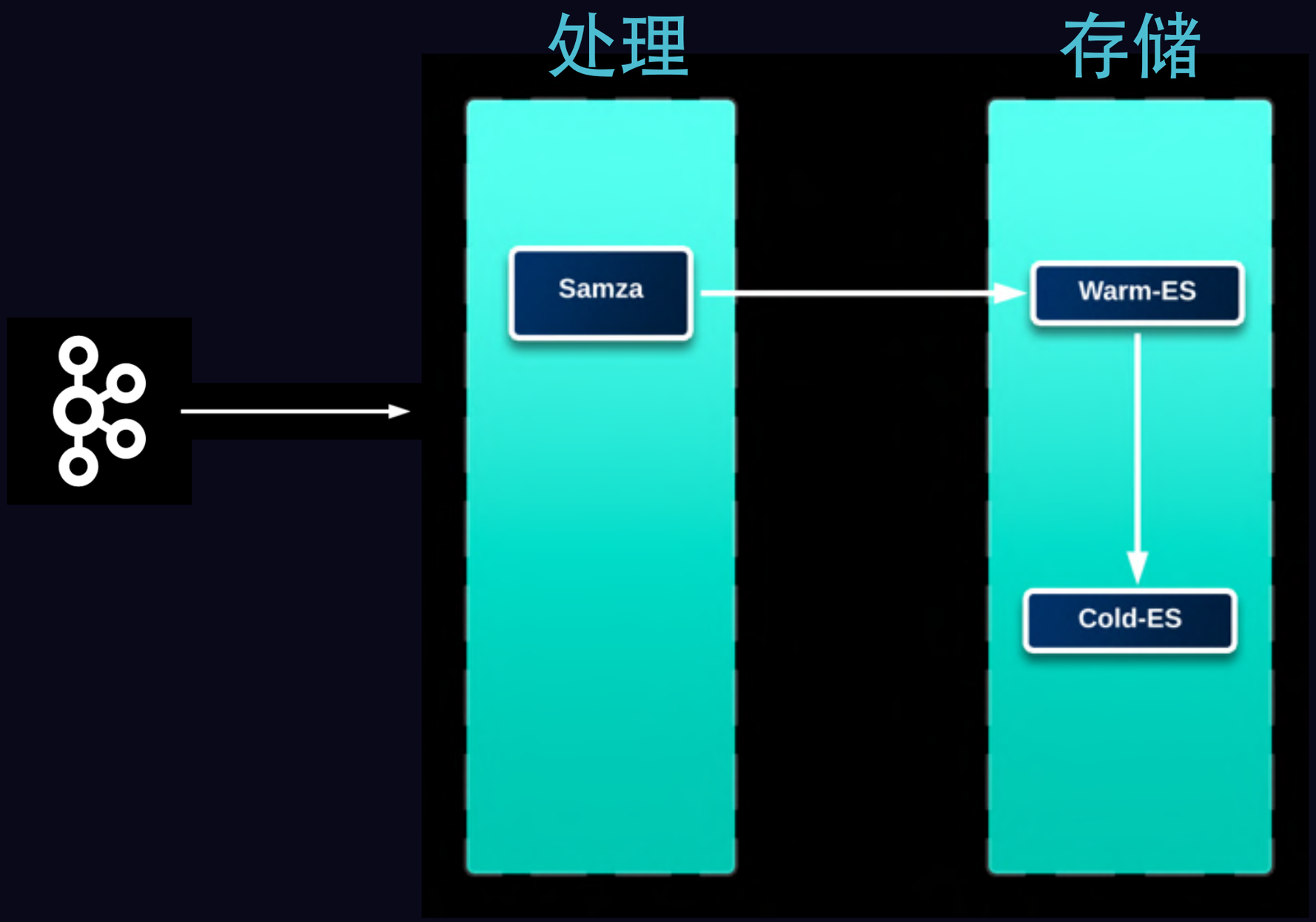


DAG on Kafka

与Kafka的一流整合

内置检查点

内置状态管理

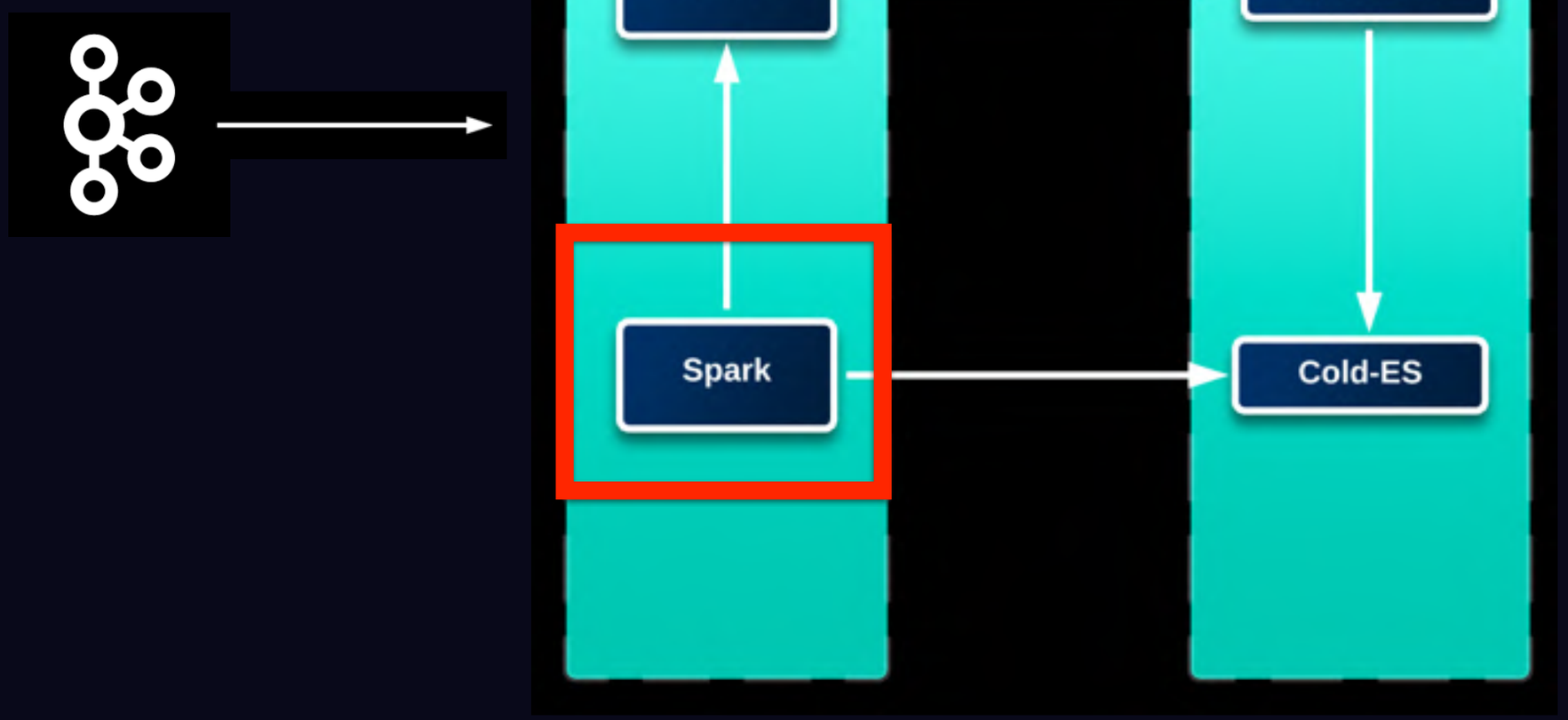

处理
存储
Samza
Warm-ES
Cold-ES

存储层当掉怎么办?

预处理耗时太久怎么办?

处理

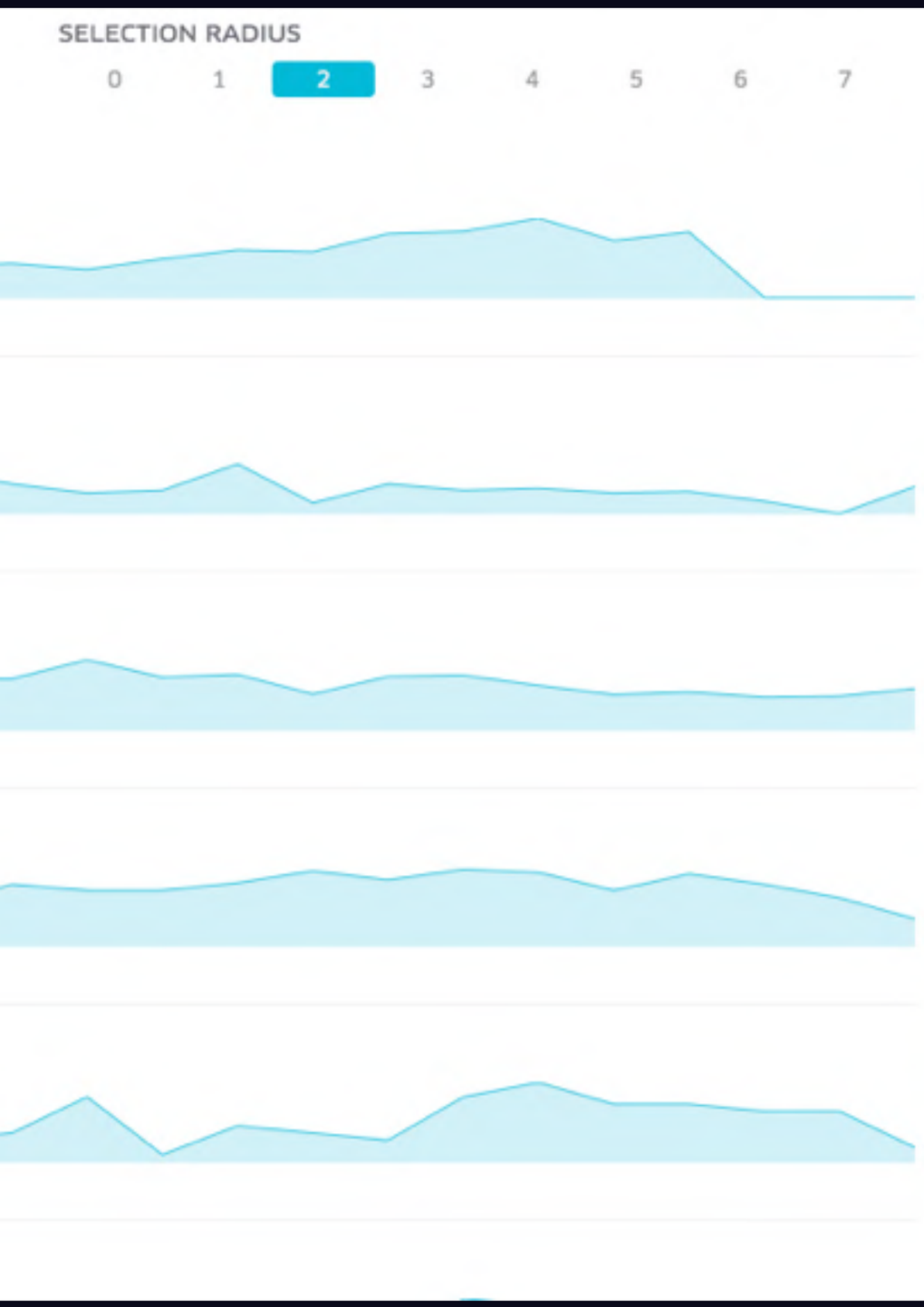
存储

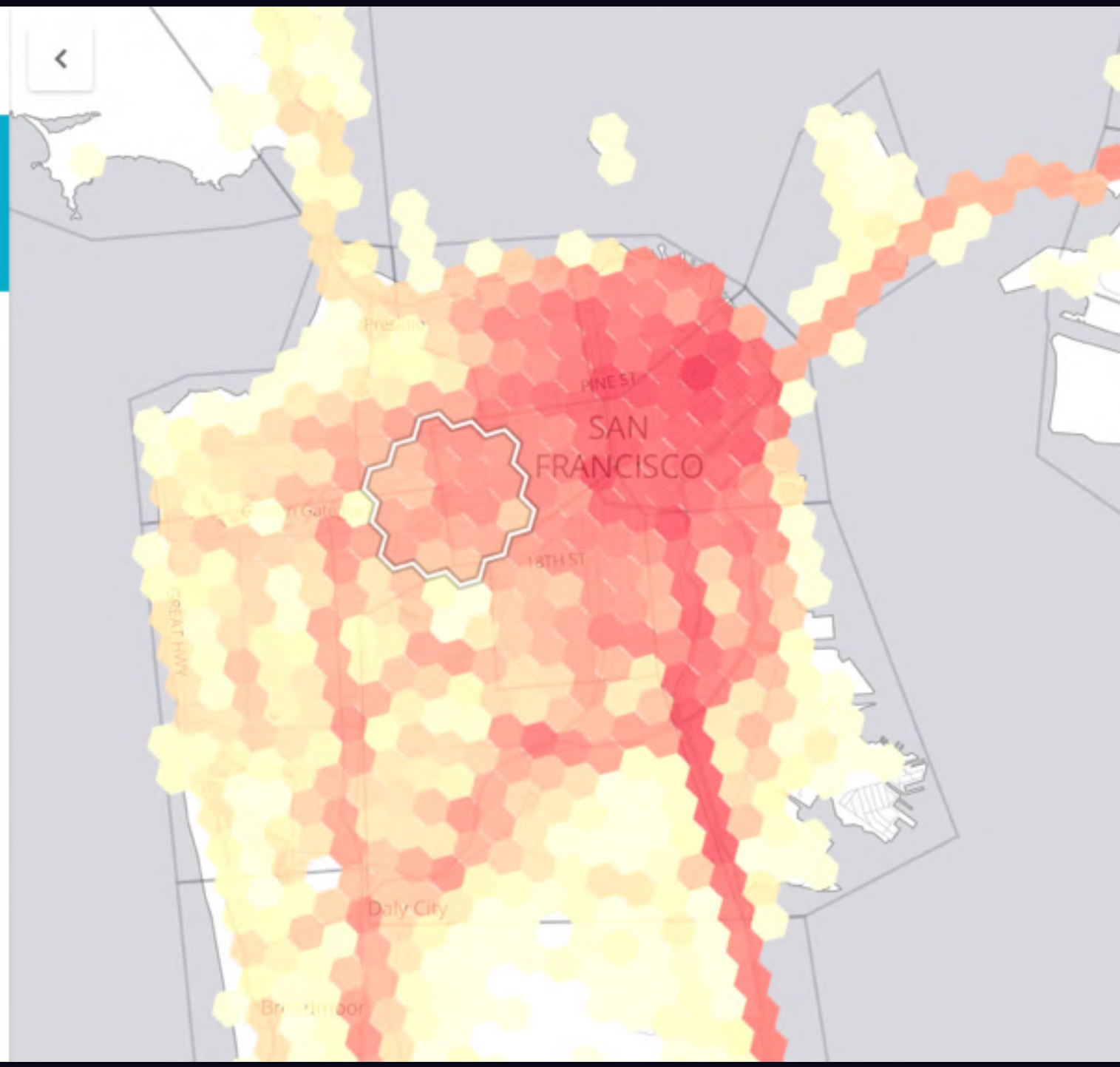


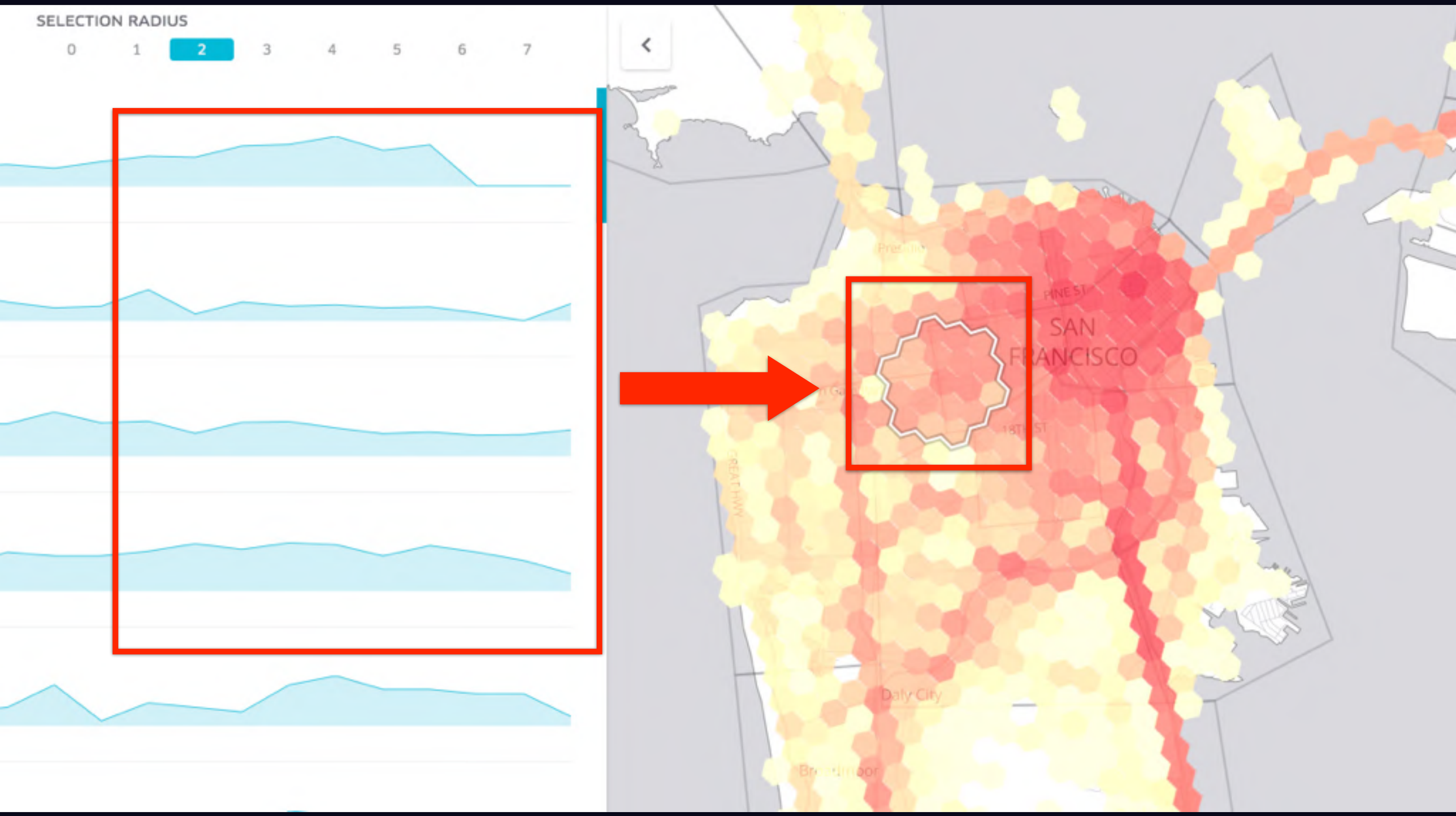
终于搞定了?

SELECTION RADIUS

0 1 2 3 4 5 6 7



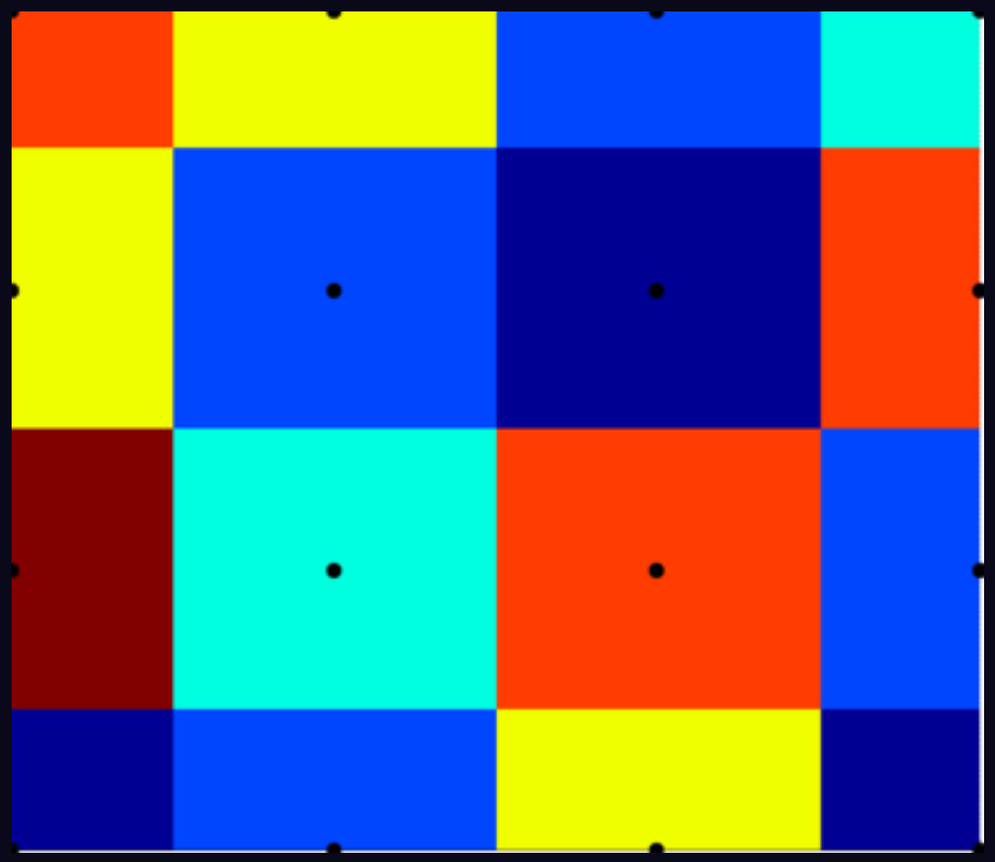


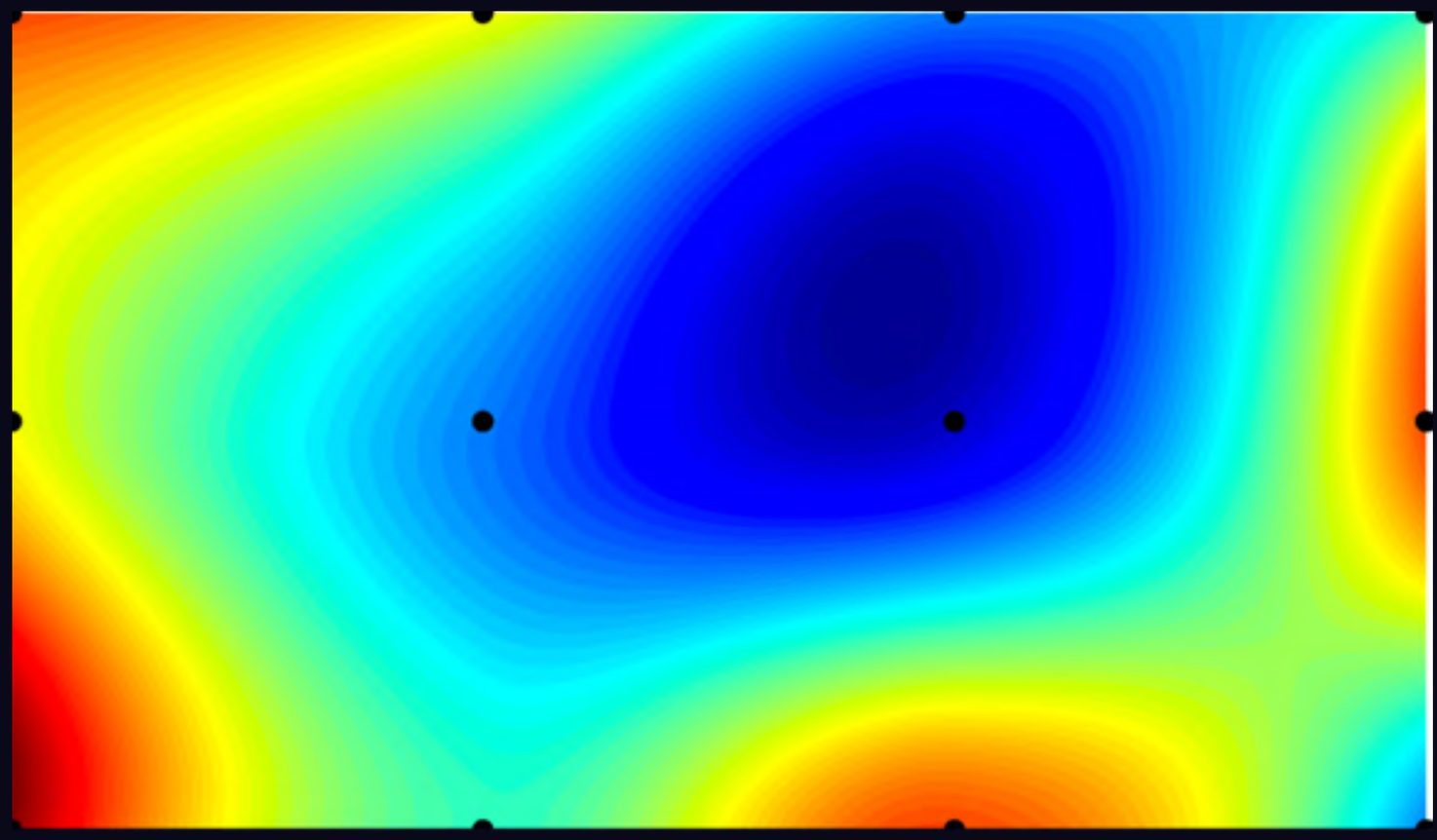

SELECTION RADIUS
0
1
2
3
4
5
6
7
SAN
FRANCISCO
Daly City

后期处理

查询结果转换和平滑处理

查询结果转换和平滑处理





计算规模

一个城市至少10,000六边形

计算规模

每个六边形331个邻居需要处理

计算规模

一次查询：331 x 10,000 = 310万六边形

计算规模

99%-ile 处理时间: 70ms

简单架构

Scalability! But at what COST?

Frank McSherry
Unaffiliated

Michael Isard
Unaffiliated*

Derek G. Murray
Unaffiliated†

Abstract

We offer a new metric for big data platforms, COST, or the Configuration that Outperforms a Single Thread. The COST of a given platform for a given problem is the hardware configuration required before the platform outperforms a competent single-threaded implementation. COST weighs a system's scalability against the overheads introduced by the system, and indicates the actual performance gains of the system, without rewarding systems that bring substantial but parallelizable overheads.

We survey measurements of data-parallel systems recently reported in SOSP and OSDI, and find that many systems have either a surprisingly large COST, often hundreds of cores, or simply underperform one thread for all of their reported configurations.

1 Introduction

> "You can have a second computer once you've shown you know how to use the first one."
>
> —Paul Barham

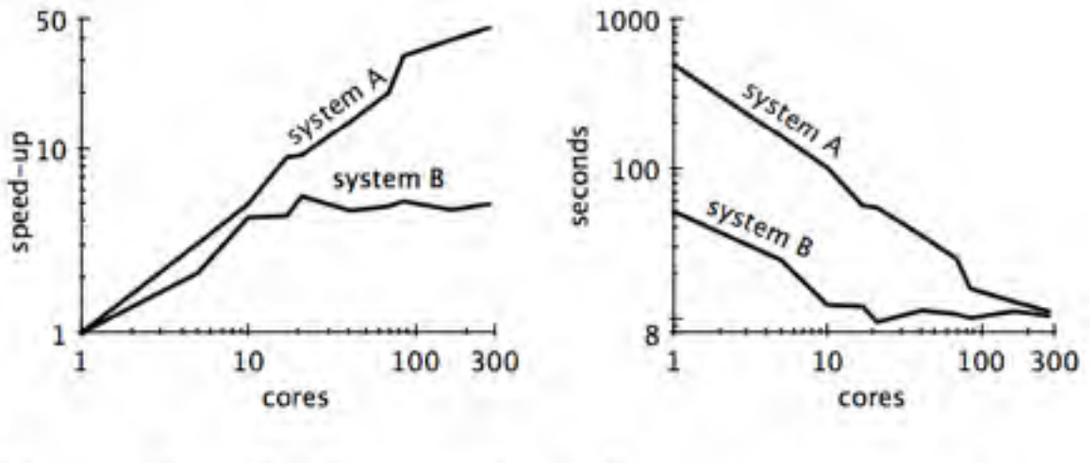


Figure 1: Scaling and performance measurements for a data-parallel algorithm, before (system A) and after (system B) a simple performance optimization. The unoptimized implementation "scales" far better, despite (or rather, because of) its poor performance.

While this may appear to be a contrived example, we will argue that many published big data systems more closely resemble system A than they resemble system B.

1.1 Methodology

In this paper we take several recent graph processing papers from the systems literature and compare their re-

Connectivity	cores	twitter_rv	uk_2007_05
Spark	128	1784s	8000s+
Giraph	128	200s	8000s+
GraphLab	128	242s	714s
GraphX	128	251s	800s

Connectivity	cores	twitter_rv	uk_2007_05
Spark	128	1784s	8000s+
Giraph	128	200s	8000s+
GraphLab	128	242s	714s
GraphX	128	251s	800s
Laptop	1	153s	417s

Connectivity	cores	twitter_rv	uk_2007_05
Spark	128	1784s	8000s+
Giraph	128	200s	8000s+
GraphLab	128	242s	714s
GraphX	128	251s	800s
Laptop	1	~~153s~~ 15s	~~417s~~ 30s

“You can have a second computer once you’ve shown you know how to use the first one.”

- Paul Graham

后期处理

- 每个处理单元都是纯函数
- 通过组合算子组合处理单元

后期处理

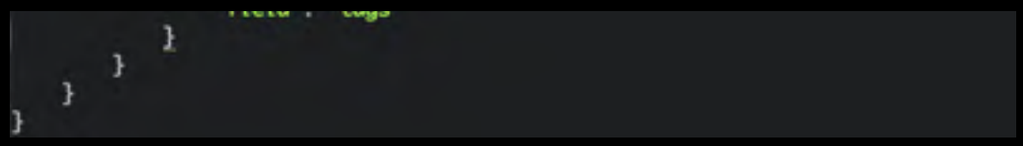
- 高度并行化的执行
- 流水线

务实考量

数据发现

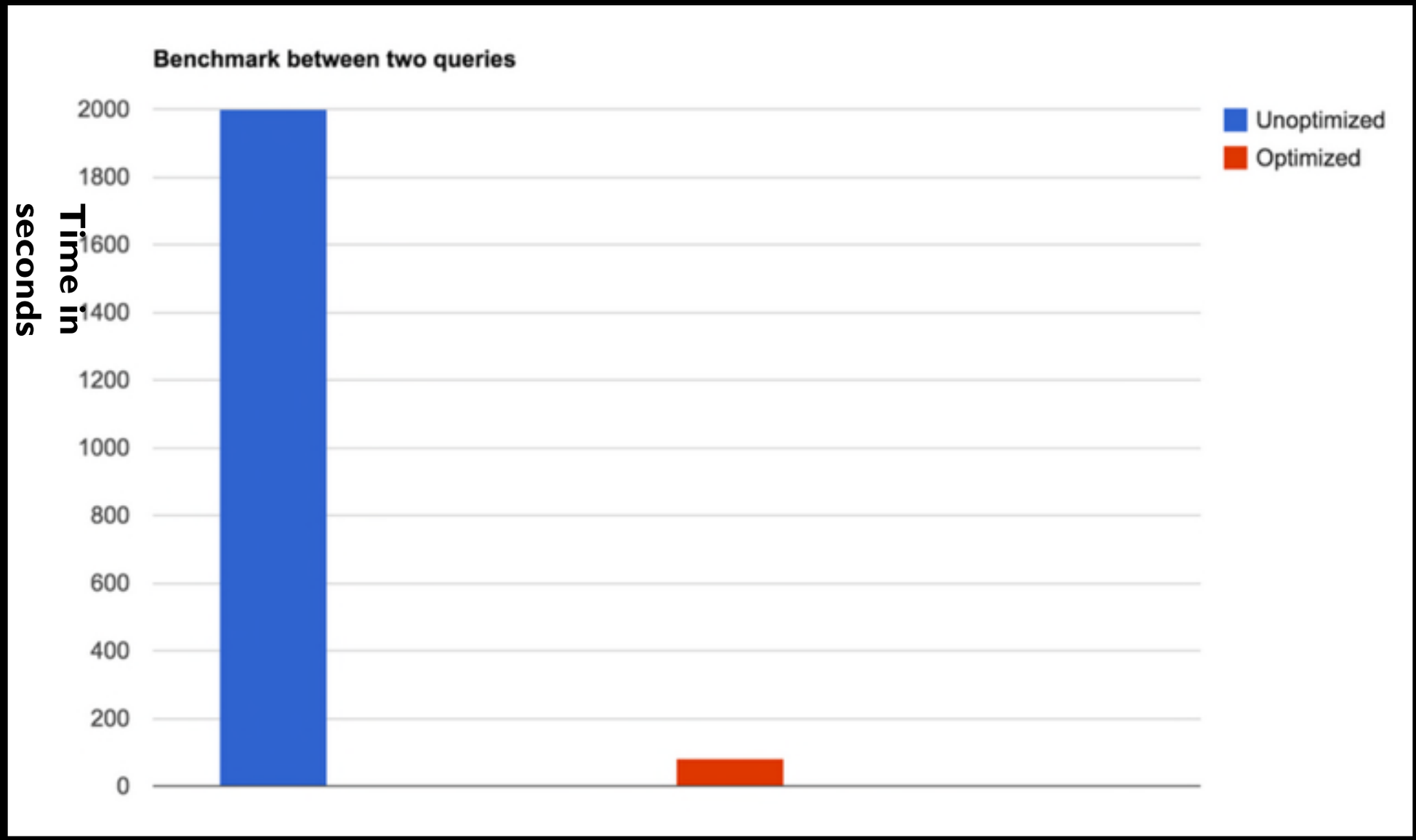
Elasticsearch 查询语句过度复杂

```
SELECT timeseries(7d)
FROM driverAcceptanceRate
WHERE geo_dist(10, [37, 22])
AND time IN (2015-02-04,2015-03-06)
AND msg.driverId = 1
```

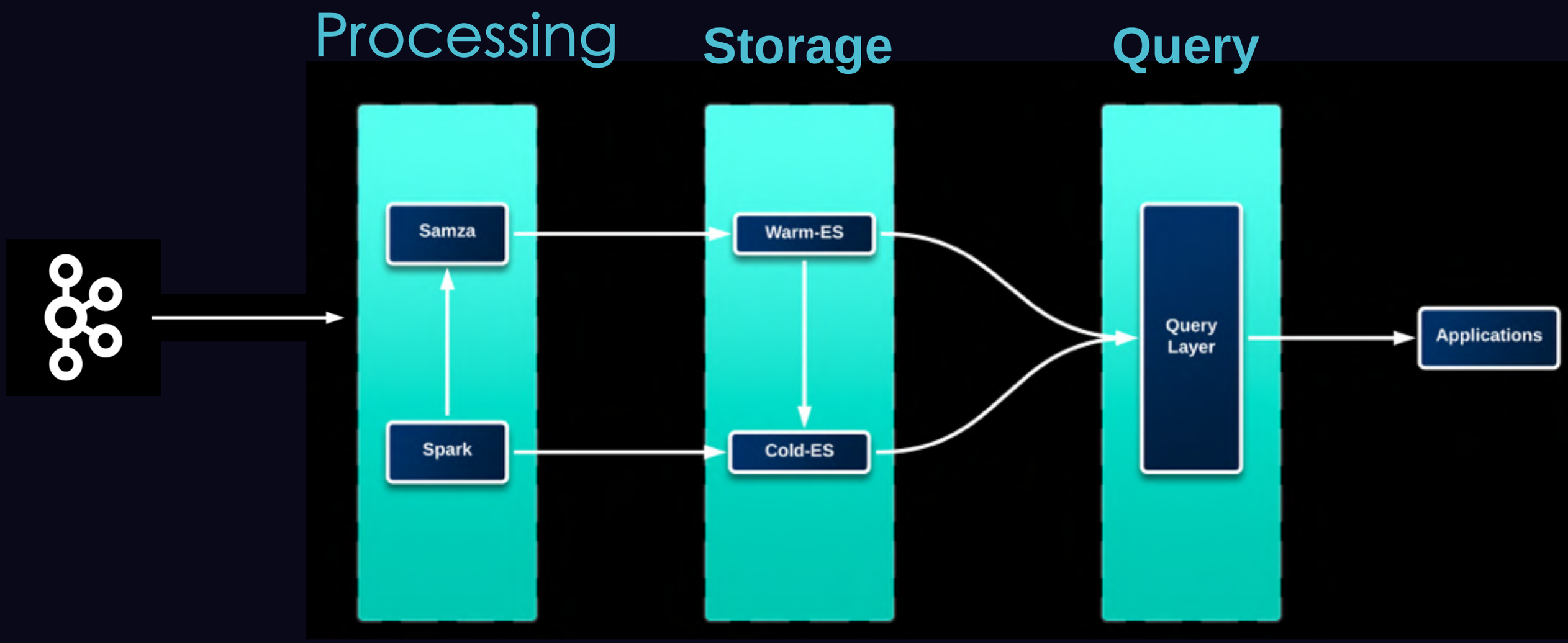


Elasticsearch 查询可以优化

- 流水线
- 查询验证
- 查询限速


Benchmark between two queries
Time in seconds
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Unoptimized
Optimized

Elasticsearch 也许会被替换


Processing
Storage
Query
Samza
Spark
Warm-ES
Cold-ES
Query Layer
Applications

还有一件事

数据流里总有不同模式

总有快速探索发现模式的需要

多少司机在5分钟内连续取消请求5次以上

哪些乘客半小时内在相距超过100公里的地方叫车?

Complex Event Processing

```
FROM driver_canceled#window.time(10 min)
SELECT clientUUID, count(clientUUID) as cancelC
GROUP BY clientUUID HAVING cancelCount > 10
INSERT INTO hipchat(room);
```

HipChat

Driver cancellation alert room

CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/702e n city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/3b19 in city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/d6e0) in city 1
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/8b58) in city 1
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/b191) in city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/bc5c) in city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/e487 in city 5

Xiaomin Dong joined the room

CAG Bot 3 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/8d56 in city 3
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/461e n city 3
CAG Bot 4 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/9fdf7 n city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/de39) in city 1
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/102a in city 3
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/8c18 in city 21
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/8d1d in city 5
CAG Bot 3 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/627e) in city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/cb9e n city 1
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/6671 in city 5
CAG Bot 4 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/cb1a in city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/be7d) in city 1
CAG Bot 6 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/627e) in city 5
CAG Bot 10 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/627 0) in city 5
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/33d2) city 1
CAG Bot 10 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/627 0) in city 5
CAG Bot 12 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/627 0) in city 5
CAG Bot 3 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/cb9e n city 1
CAG Bot 3 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/540a in city 1
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/e3c7 n city 3
CAG Bot 2 driver cancellations detected within the last 10 minutes on the same client (https://toolshed.uberinternal.com/t2/clients/e5a4 in city 5

简单实现

谢谢！

UBER