

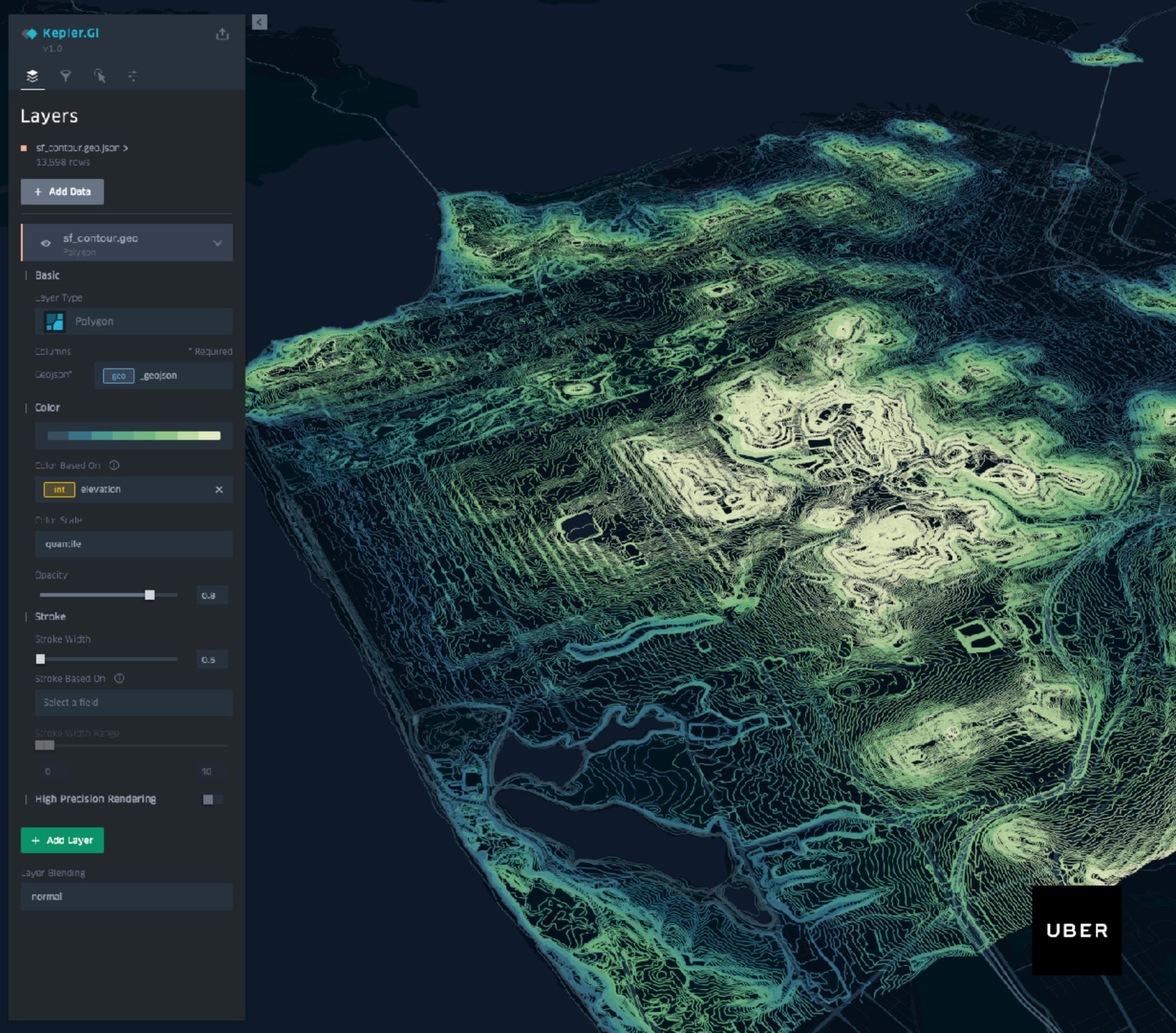
kepler.gl在海量地理定位数据可视化的应用

何珊

@heshan_cheri

Uber数据可视化工程师

08.18.18





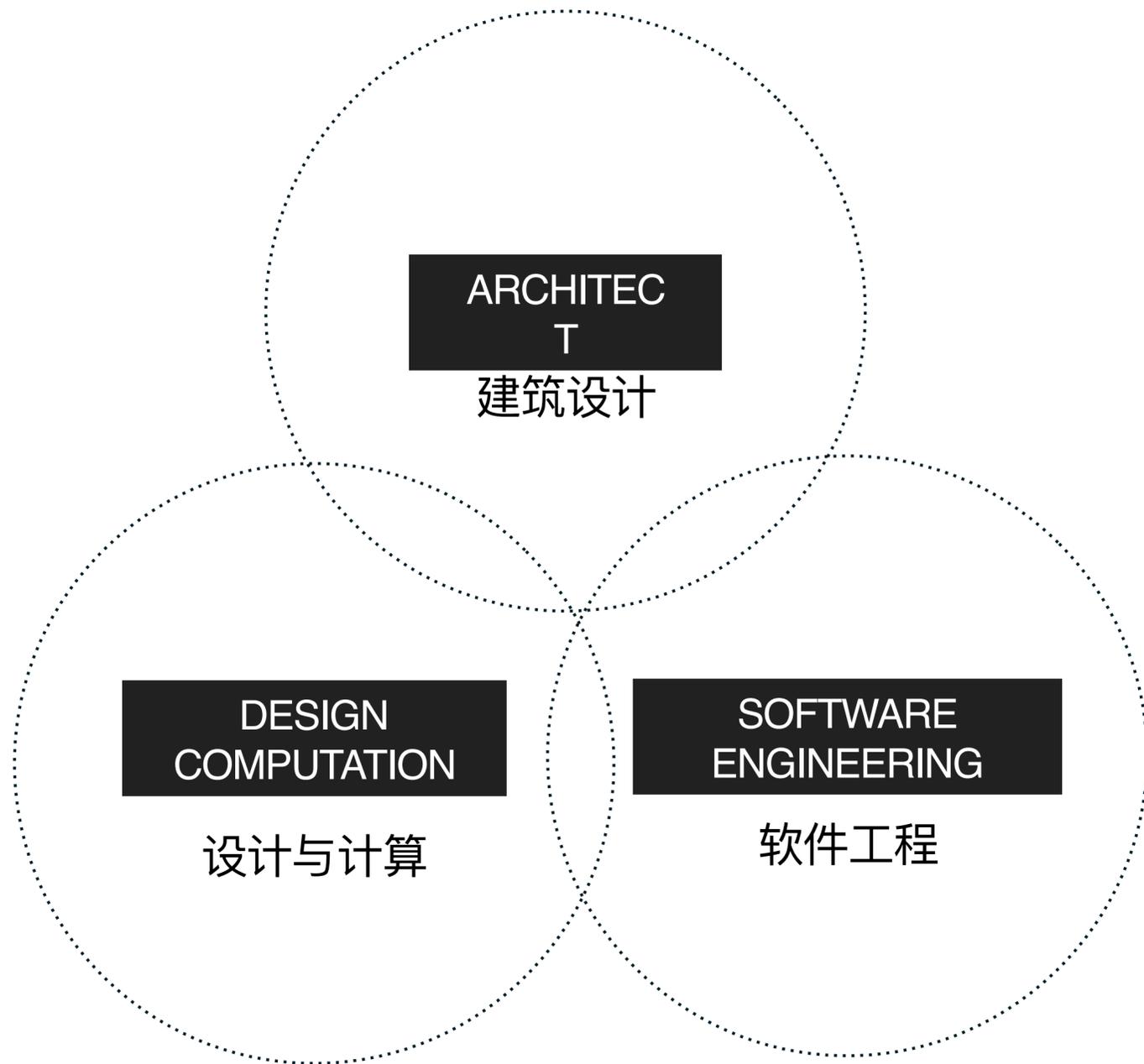
何珊

高级数据可视化工程师

@ Uber

@heshan_cheri





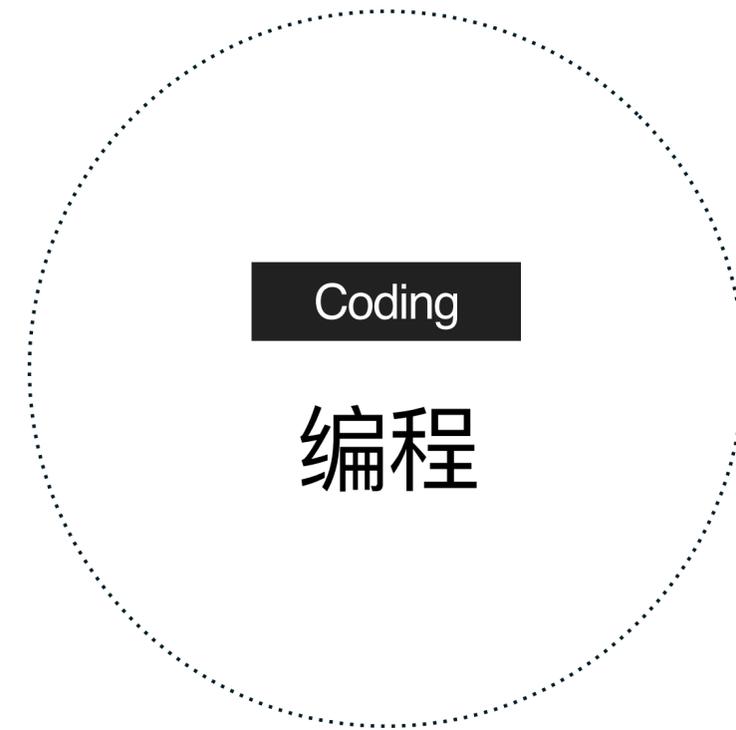
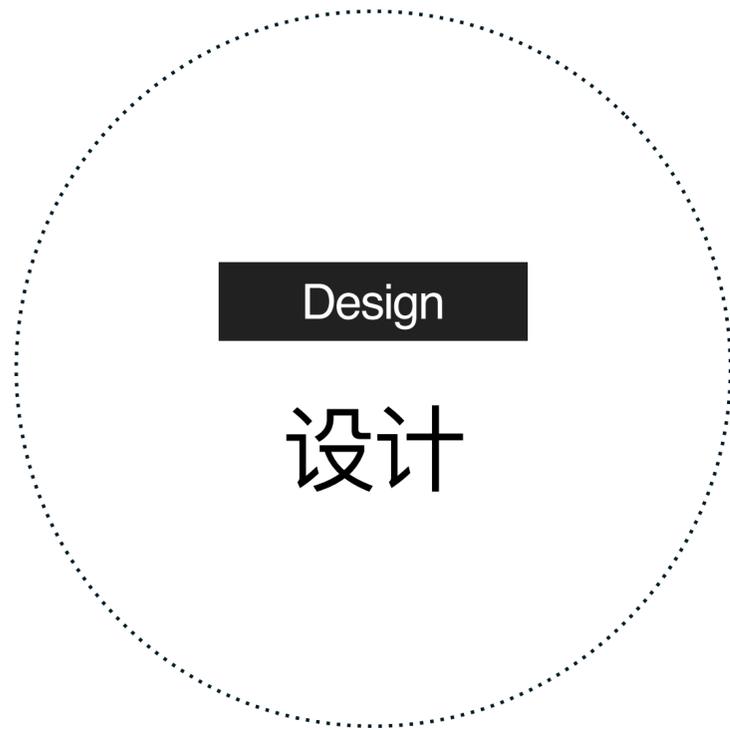
何珊

高级数据可视化工程师

@ Uber

[@heshan_cheri](#)





What is Data Visualization?

什么是数据可视化

Architecture to Data Visualization

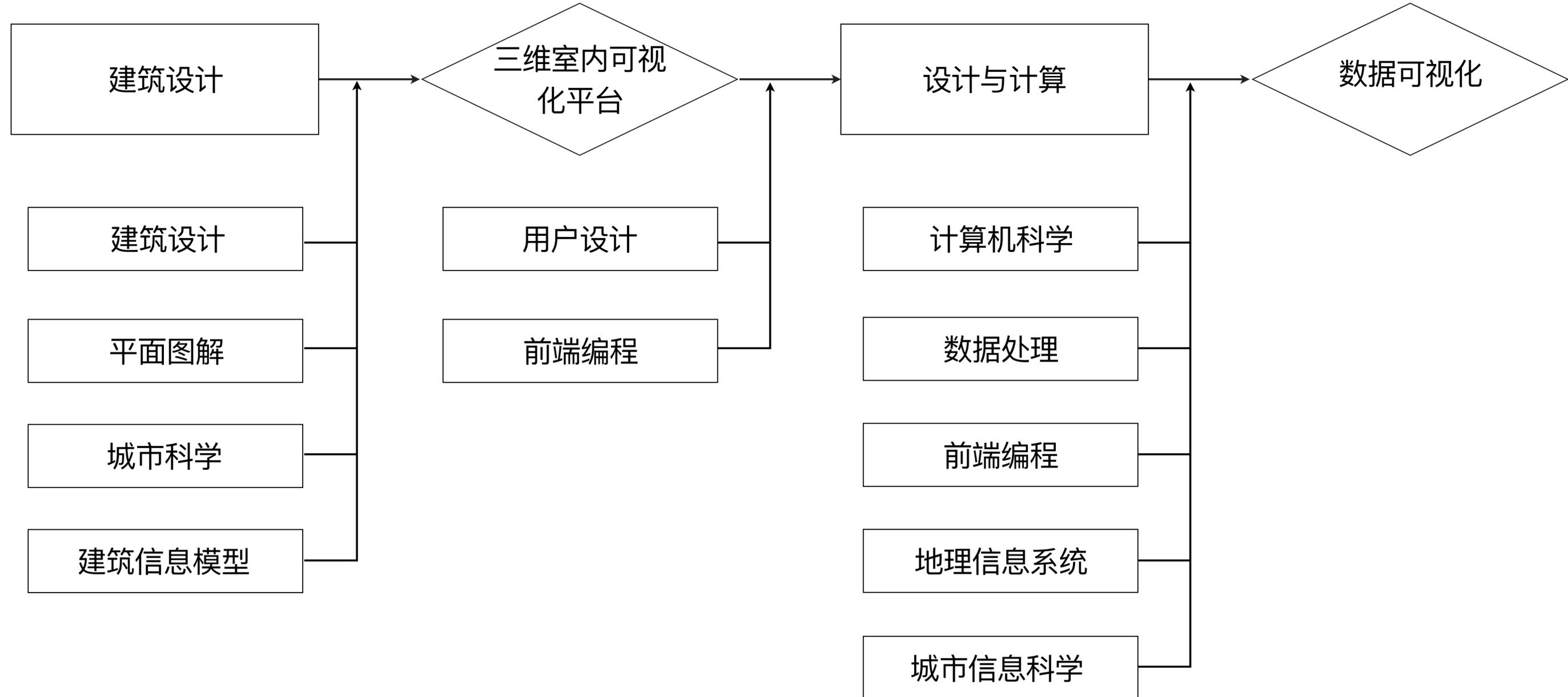
我是怎么从建筑师到可视化工程师的

Tsinghua,
Michigan

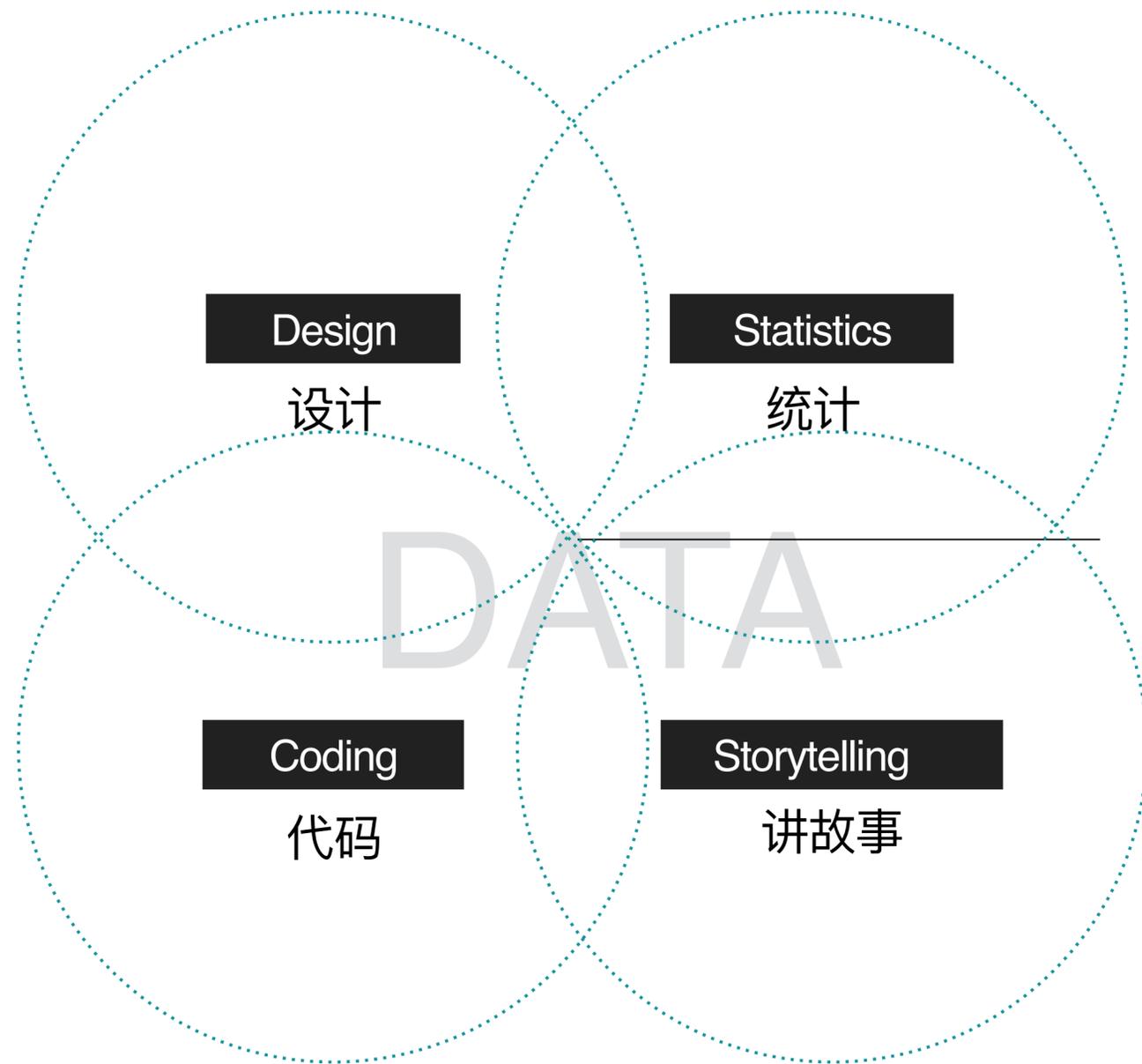
BluHomes

MIT

Uber



ARCHITECTURE -> DATA VISUALIZATION



Pattern Discovery

找寻规律

Data Consumption

让数据更容易理解

Interaction Media

交互体验媒介

Storytelling

用数据说故事

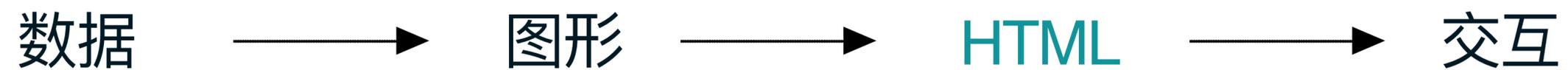
Make Data Actionable

从数据到可行性方案

Data Visualization is the Process of Translating Data into Visual Element

数据可视化是一个从数据到图形的转换过程

FrontEnd Data Visualization





Geospatial Data Visualization

地理定位的数据可视化

Uber拥有海量的地理定位数据



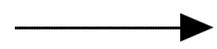




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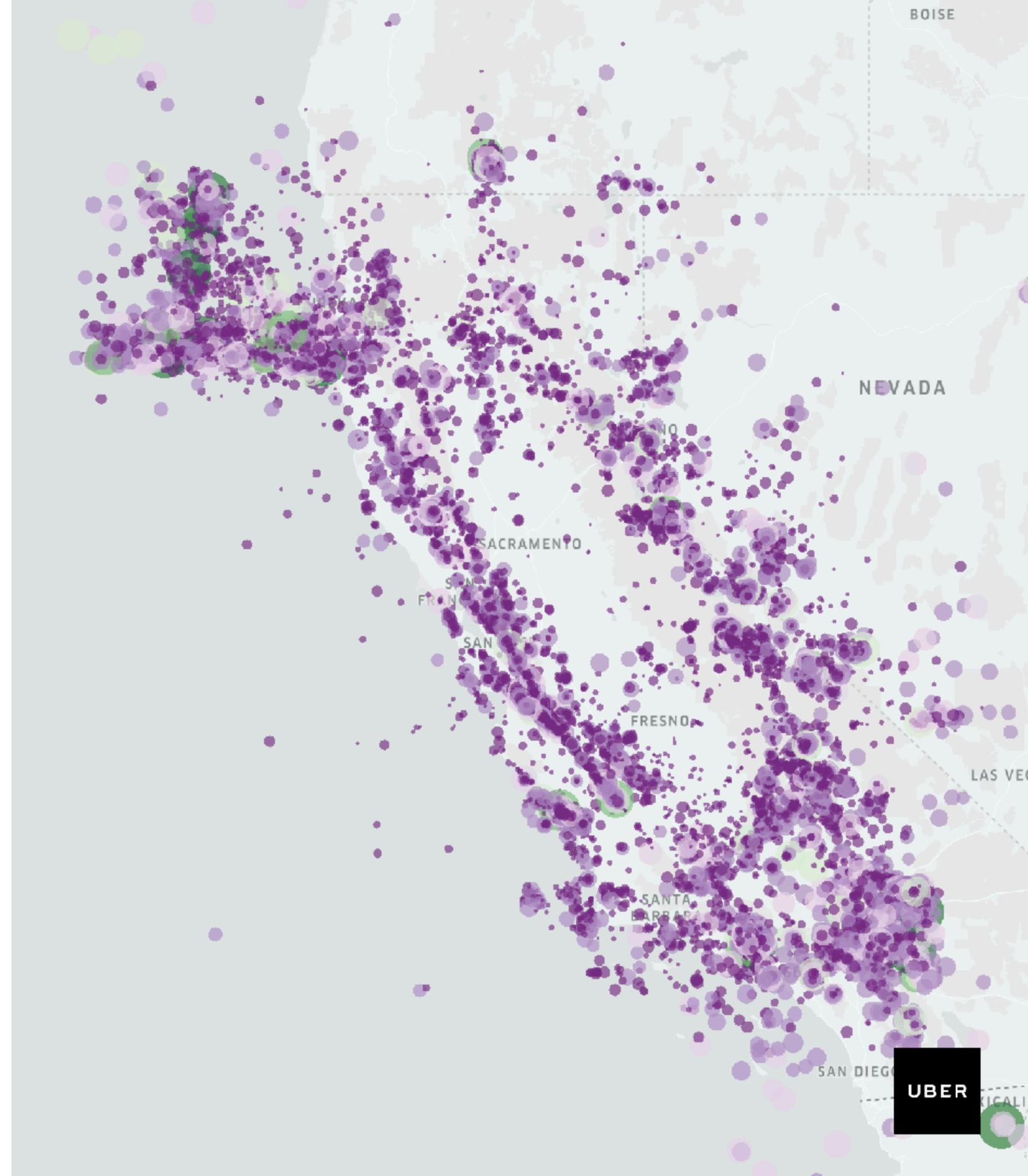
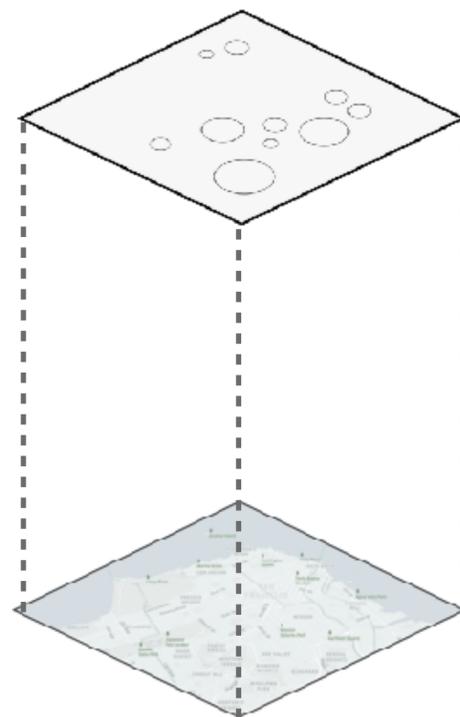
LONDON 04/09/2016

数据

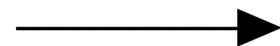


图形

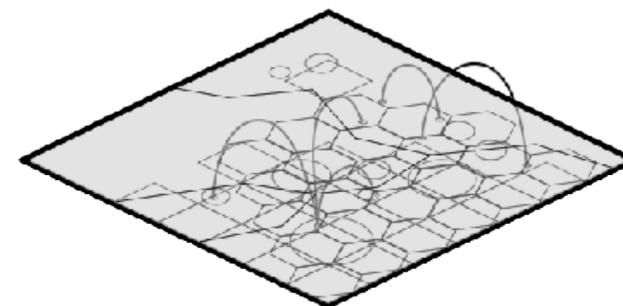
地图



数据

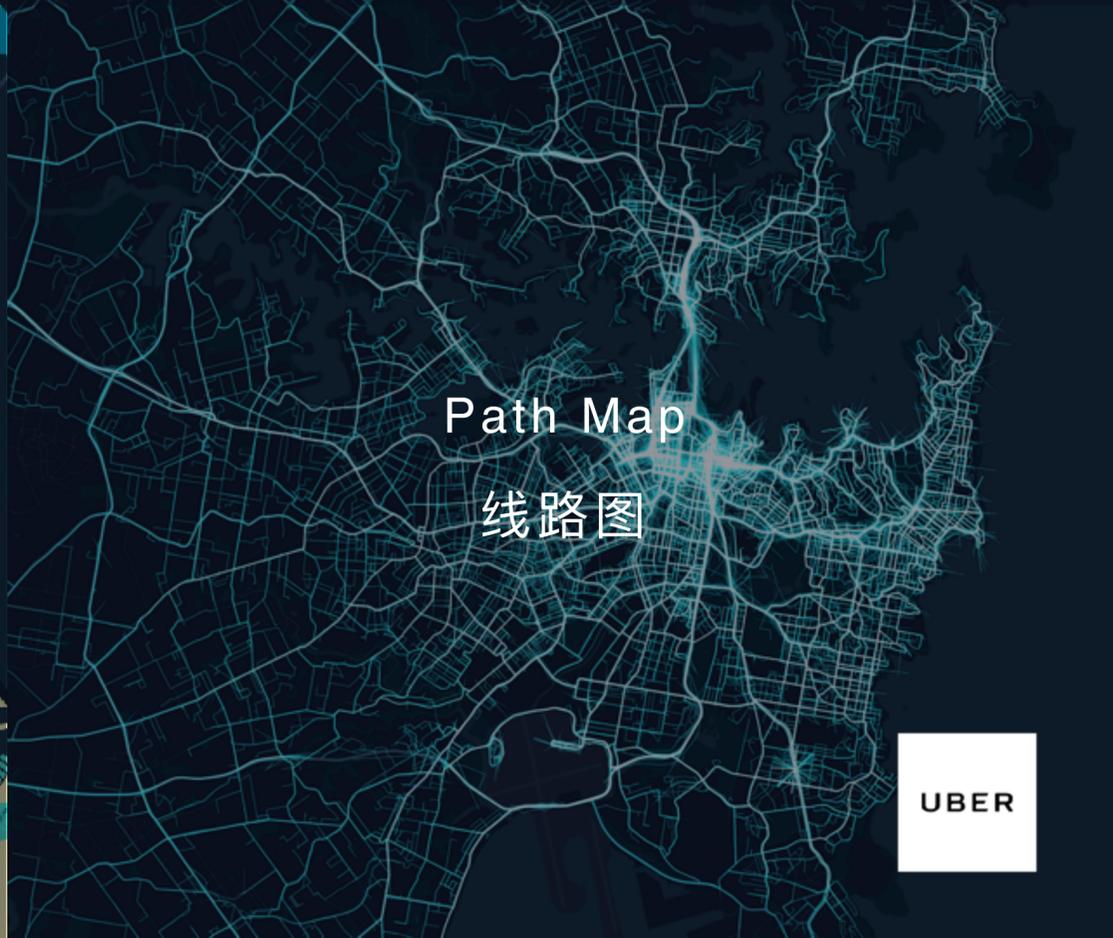
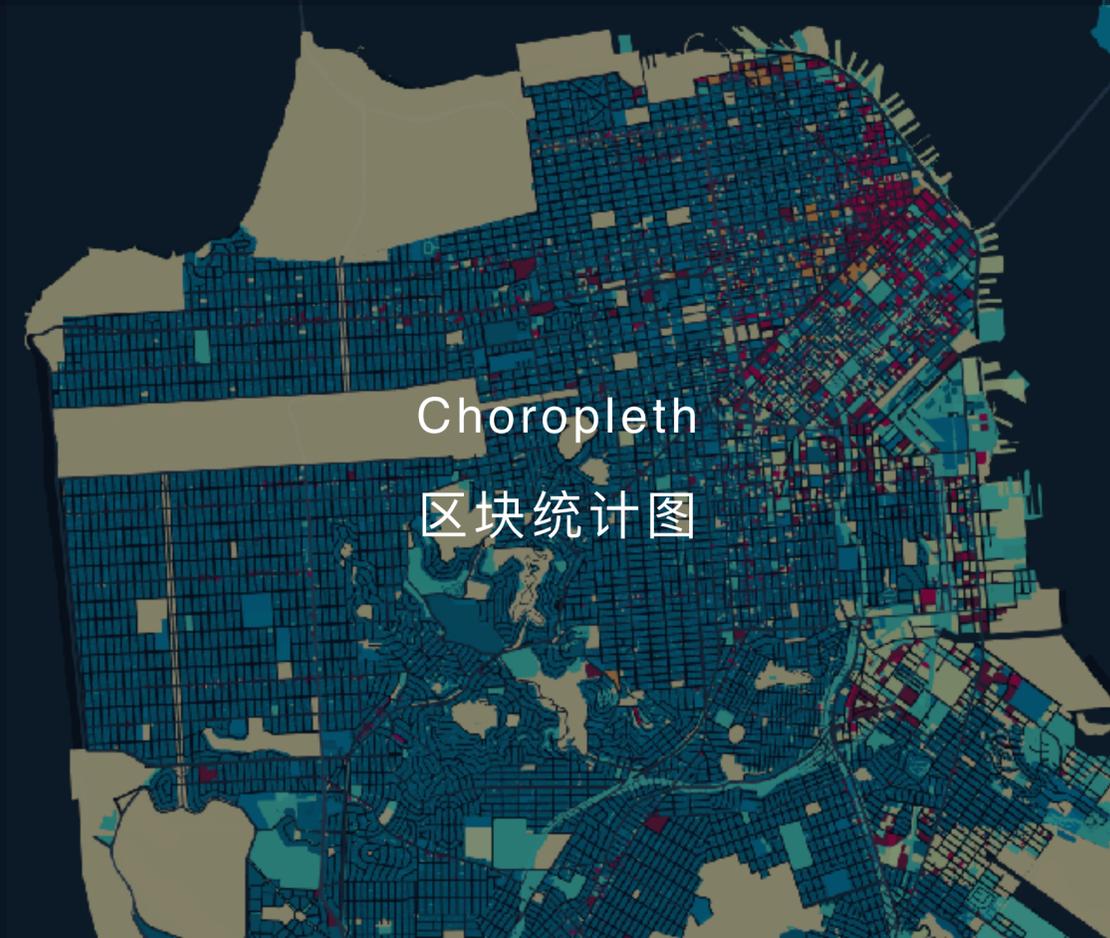
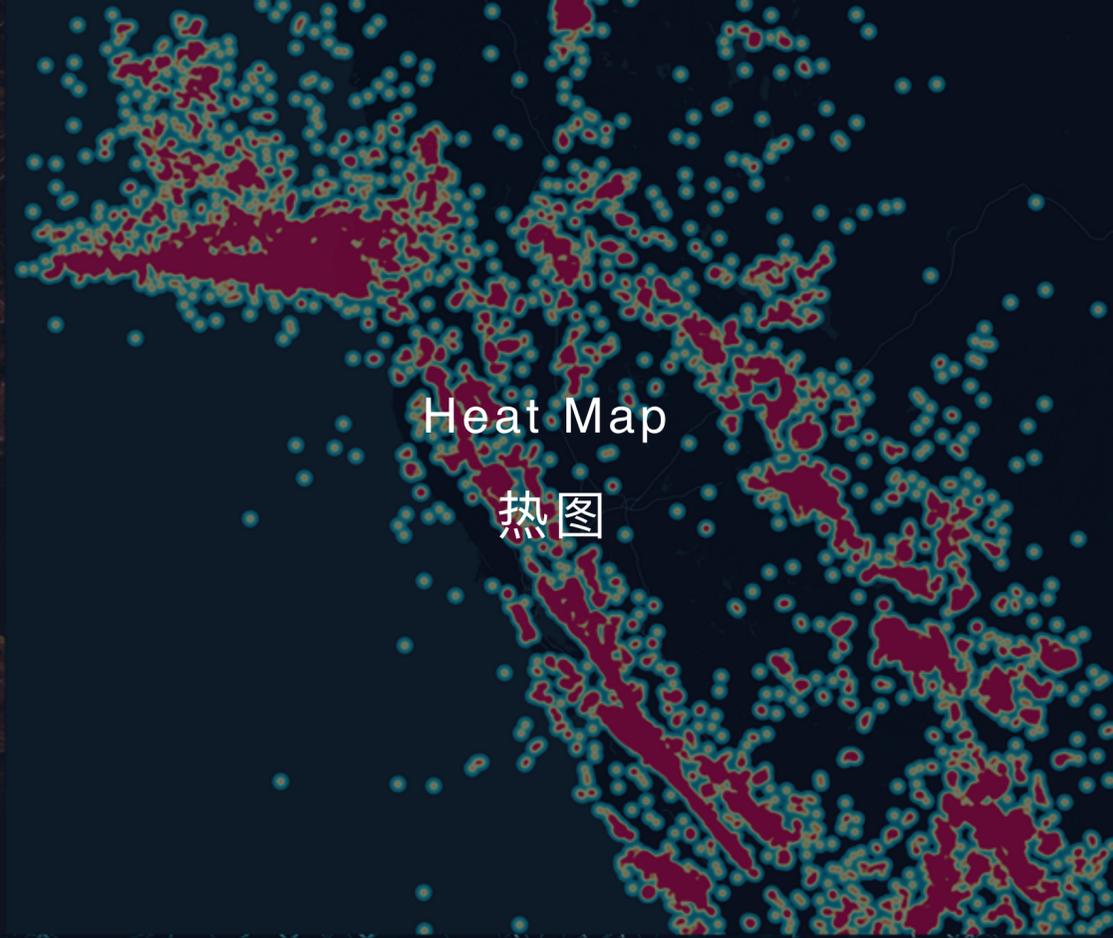
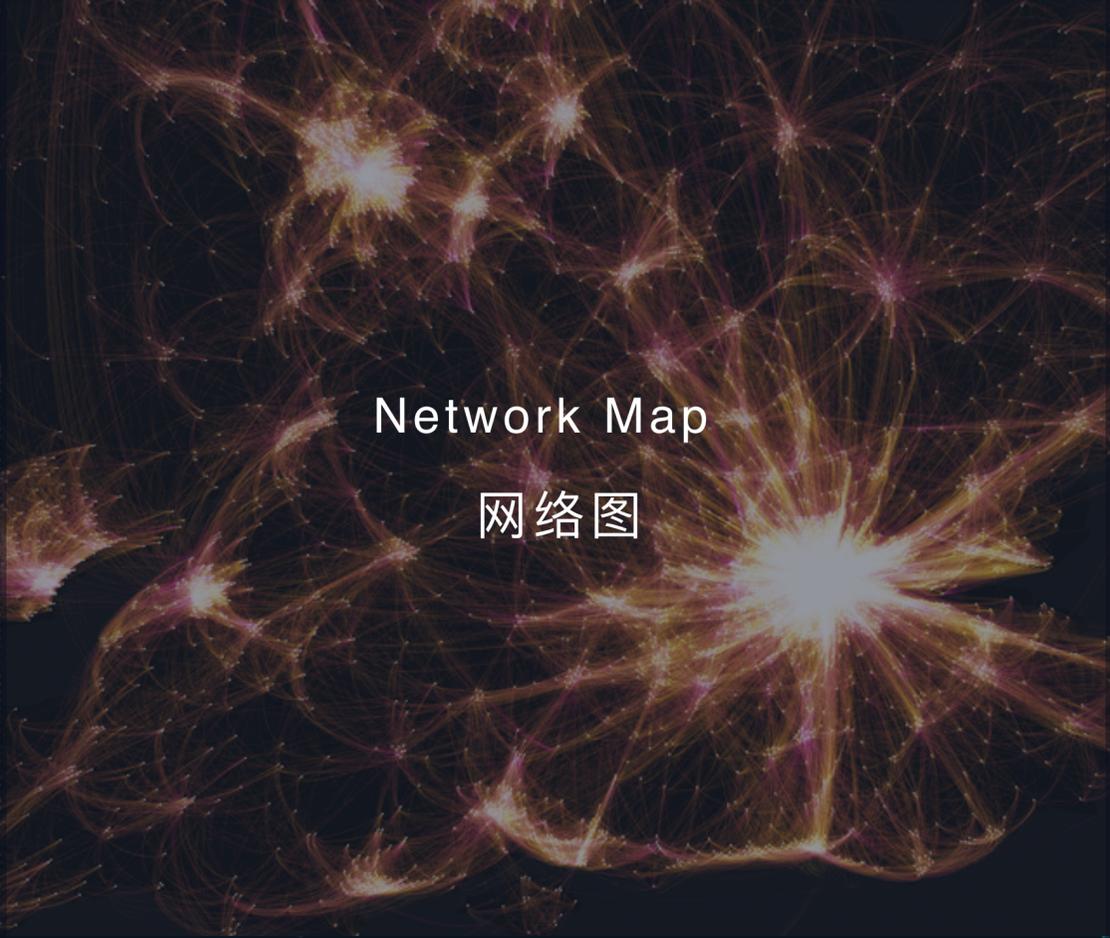


图形



Common Types of Geospatial Visualizations

常见的地理数据可视化类型



Scatterplot

散点图



3D Density Grid

三维方格密度图



Shan He, @heshan_cheri

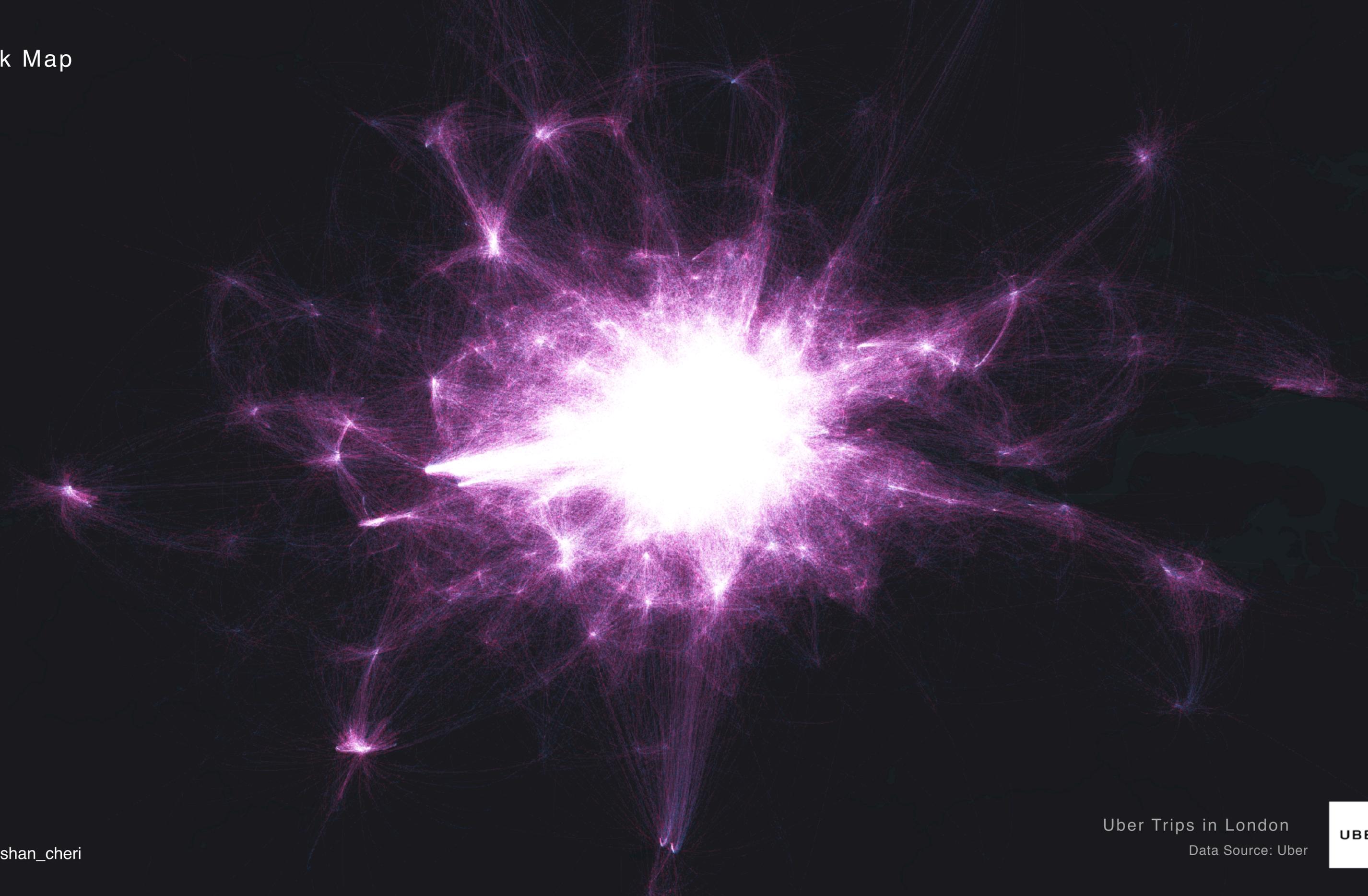
1 Million Taxi Trips In New York City

Data Source: www.nyc.gov

UBER

Network Map

网络图



Choropleth

区块统计图



Shan He, @heshan_cheri

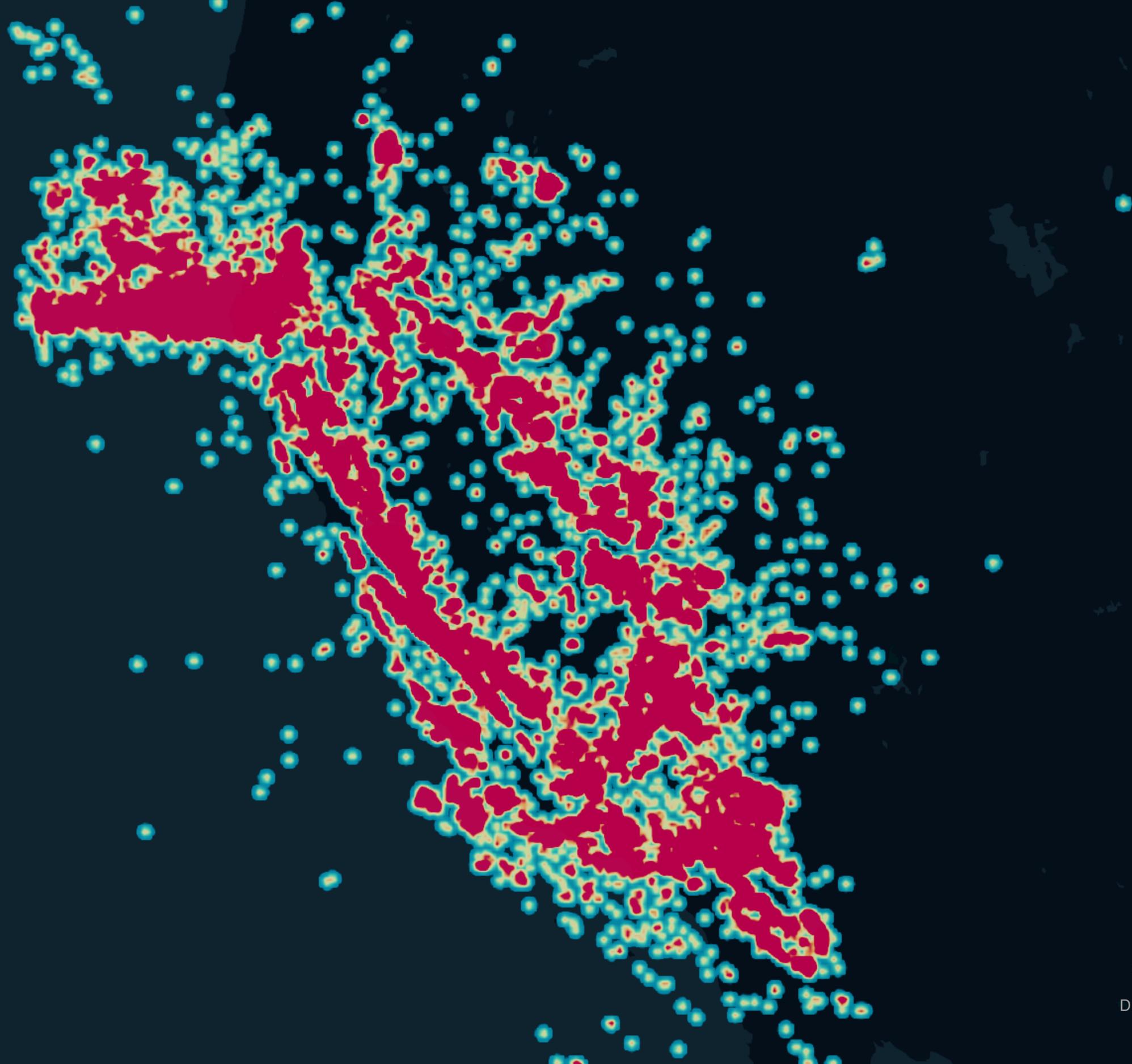
Census Tract Population in NYC

Data Source: data.cityofnewyork.us

UBER

Heat Map

热图





Path Map

线路图

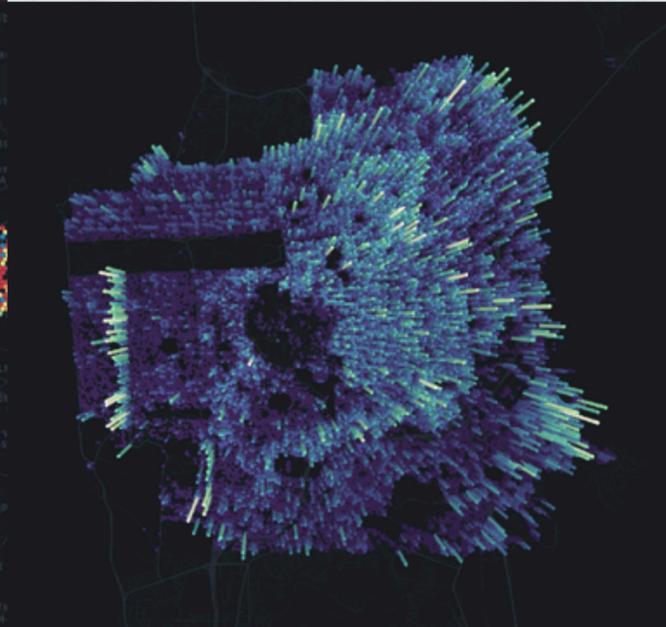
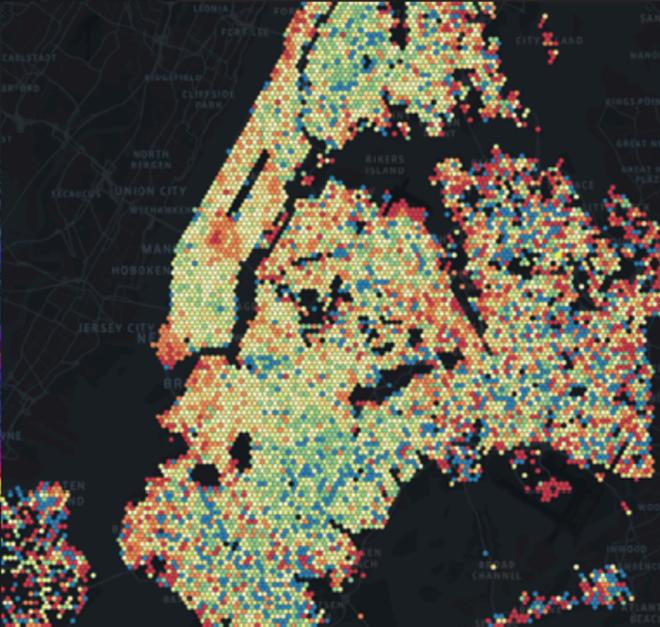
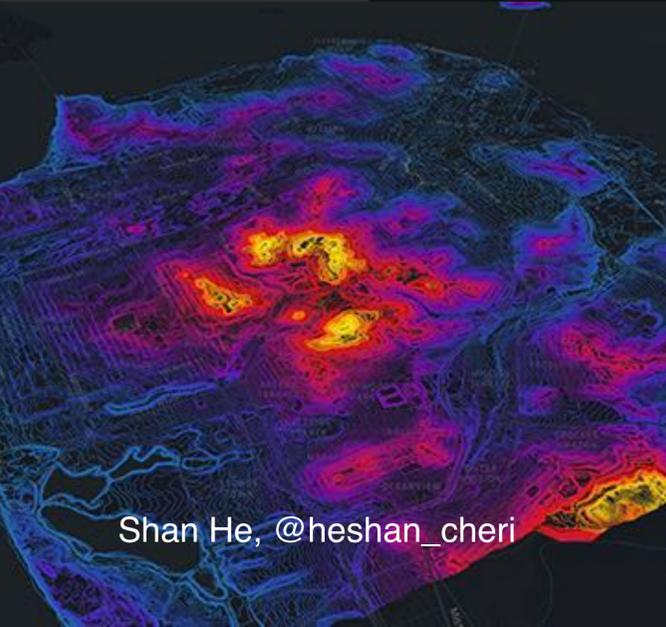
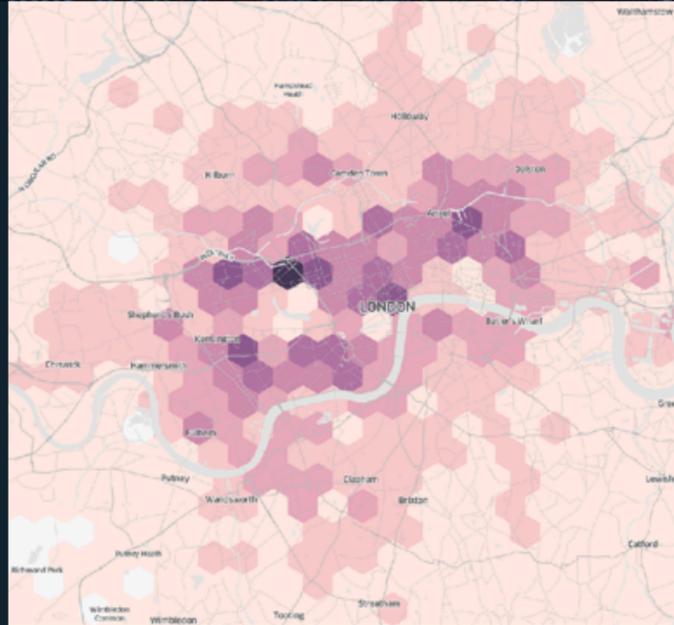
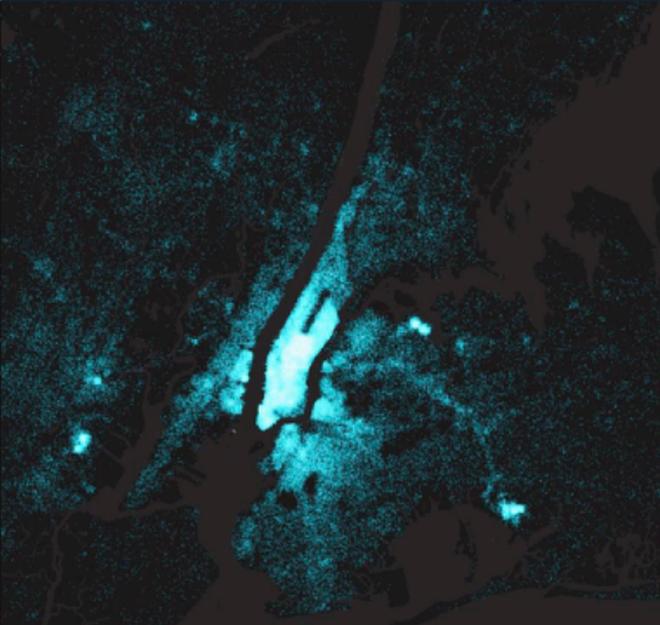
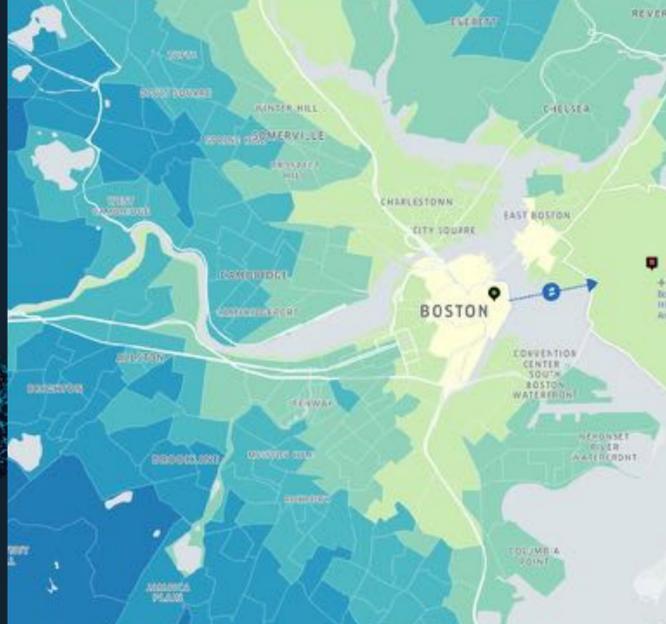
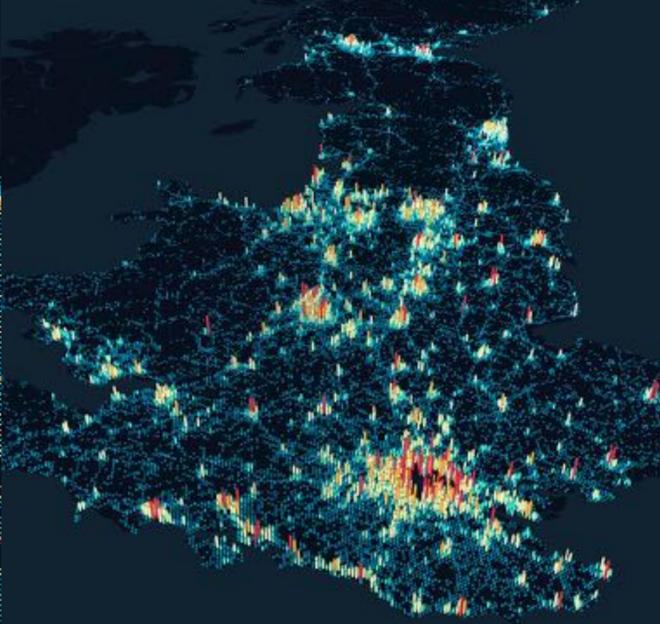
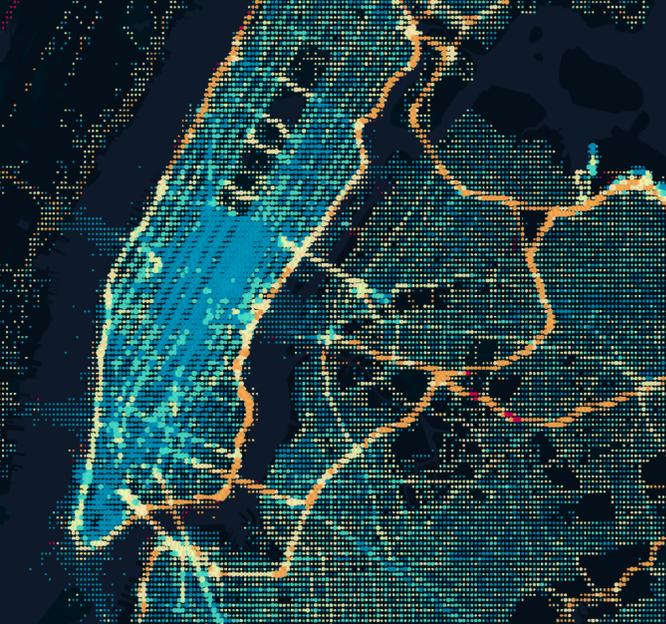


Shan He, @heshan_cheri

Uber Trips in Sydney

Data Source: Uber





Shan He, @heshan_cheri

We create visualizations to gain insights
from millions of location data

我们做数据可视化是为了从中获取有用信息

Sometimes this process can be painful

这个过程是很曲折的

In Theory...



In Reality...



MacBook Air



Creating meaningful visualizations requires a lot of trial and error.

生成一个有意义的数据可视化是需要反复尝试的

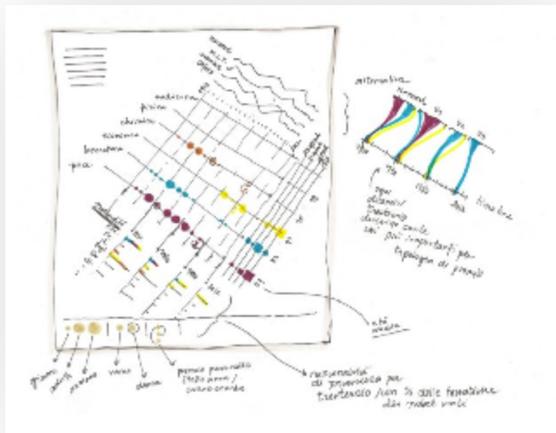
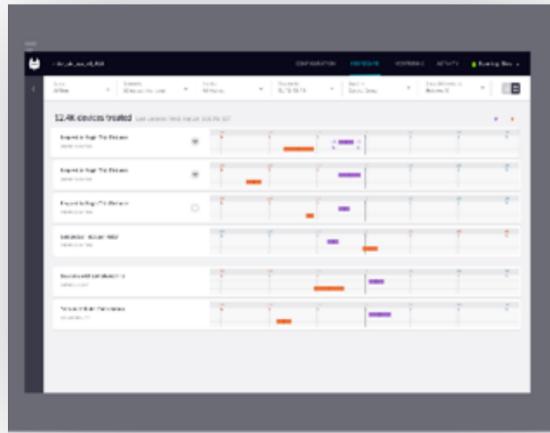
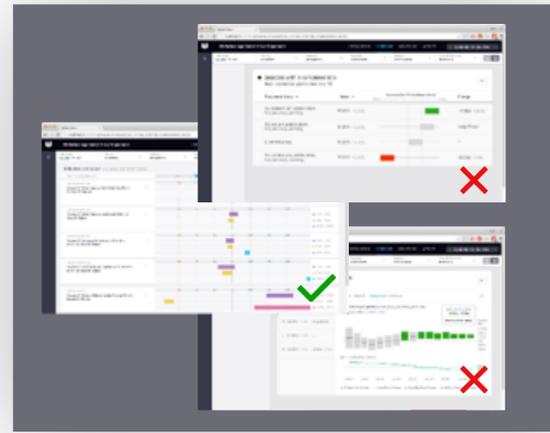


Image by: Georgia Lupi

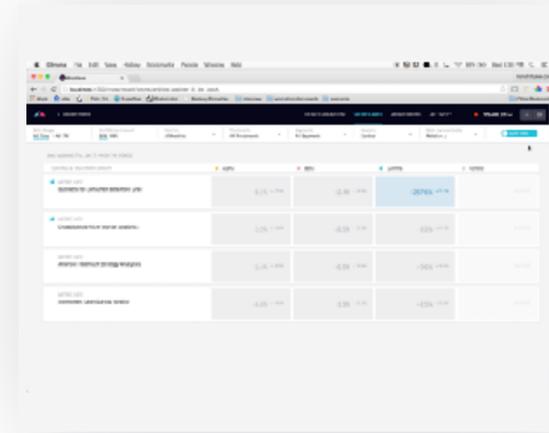
Sketch
草图



Mockup
平面样本



Prototype
原型



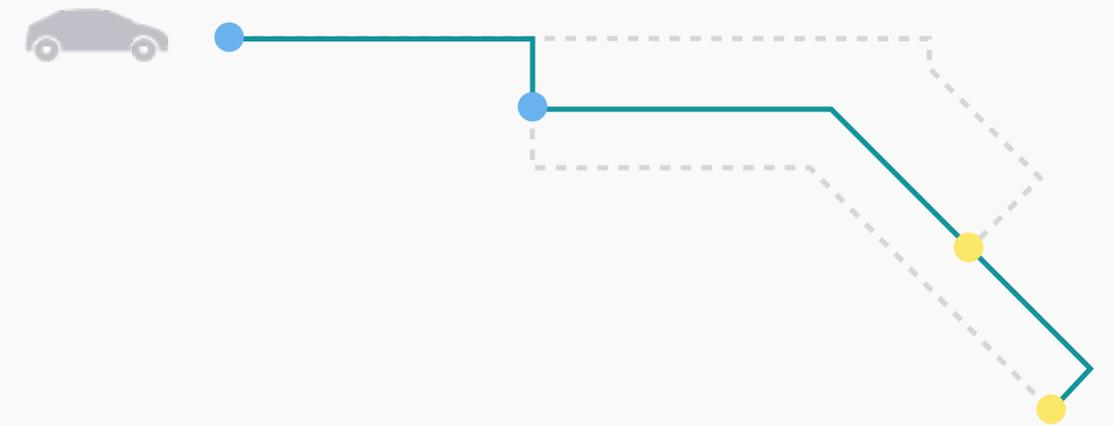
Product
产品



Task:

Create a Visualization for UberPOOL

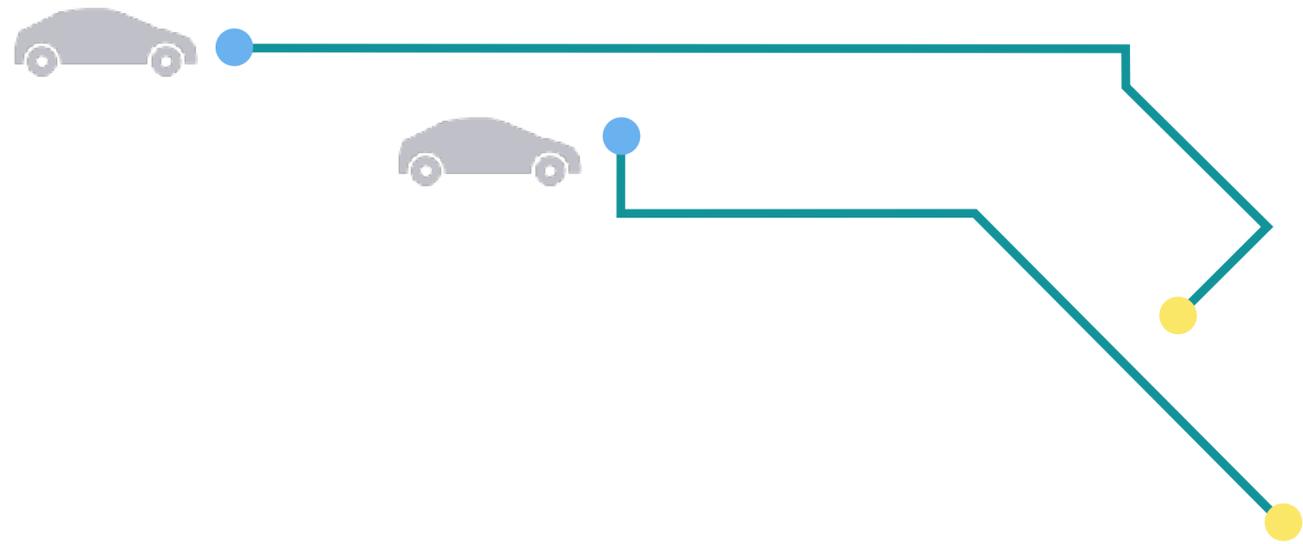
拼车时车流量的可视化



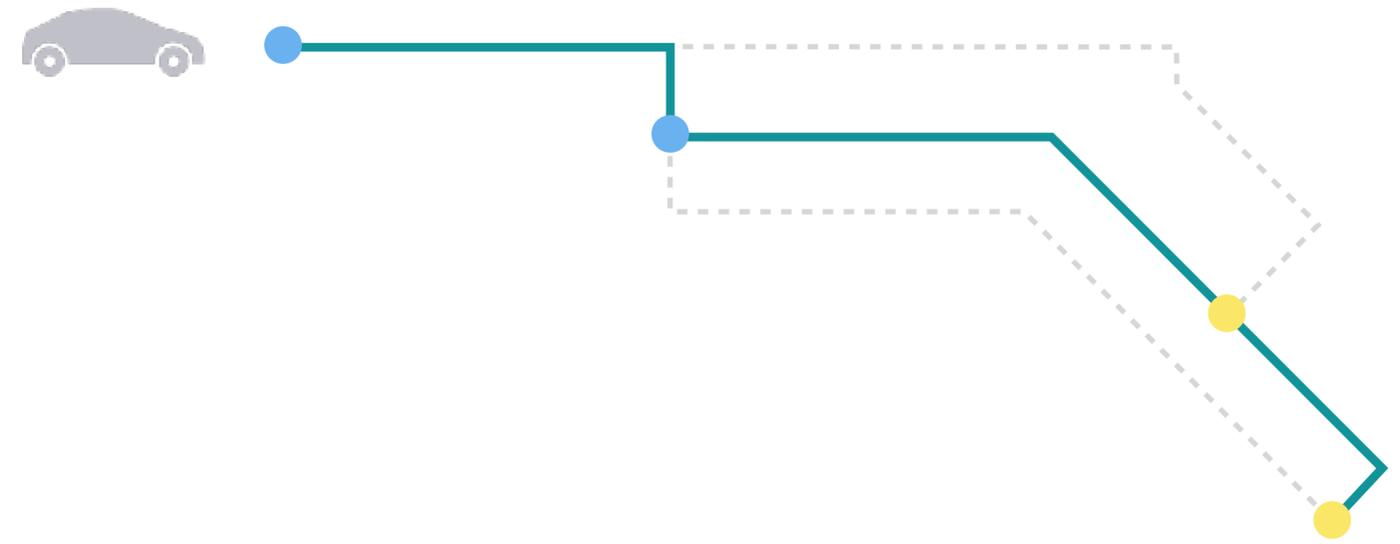
Hypothesis: Less Cars on the Road is More Efficient

拼车时车流量会变小

Data Collection



Ride Separately
模拟分别搭车的行程



UberPOOL
拼车的行程



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45a0c6b5-c22d-49cb-88fe-d04b581be463,37.77773980450325,-122.41642075541098,1481823257000,26815920
45a0c6b5-c22d-49cb-88fe-d04b581be463,37.779719886058416,-122.4168408992882,1481823345000,32338324
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45a0c6b5-c22d-49cb-88fe-d04b581be463,37.78889952715933,-122.41867374955197,1481823750000,8367109
45a0c6b5-c22d-49cb-88fe-d04b581be463,37.78974532273505,-122.41209108091957,1481823979000,191683
45a0c6b5-c22d-49cb-88fe-d04b581be463,37.791069167221536,-122.41236661475696,1481824038000,5523074
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.790749467243245,-122.43254415133143,1481821019000,14583727
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.7891090755436,-122.43220735937741,1481821097000,725344
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.78889940787226,-122.43385468365797,1481821160000,27723318
973da131-b9a0-433d-adf6-b4^C122,-122.4360562290024,1481821677000,19556281
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.782820976141984,-122.43600683375603,1481821679000,8367107
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973da131-b9a0-433d-adf6-b4c5a07c7d32,37.78255950482275,-122.43594392539389,1481821692000,8367107
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.78007956890988,-122.43544341934698,1481821811000,25414677
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.77938302684309,-122.44098060362653,1481822021000,547433
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.779316018338754,-122.44169113081686,1481822048000,547433
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.77904905417587,-122.44371723745009,1481822125000,13696736
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.776229538112084,-122.44314368253647,1481822260000,4280211
973da131-b9a0-433d-adf6-b4c5a07c7d32,37.775904924876805,-122.44574099995812,1481
MacBook-Pro-110:demos shanhe\$ █



Ride Separately

模拟分别搭车

UberPOOL

拼车

1st Try, d3 + canvas

Shan He, @heshan_cheri

UBER

Ride Separately

分别搭车



UberPOOL

拼车



2nd Try, QGIS

Shan He, @heshan_cheri



Design Tip: Use Contrast to Make it Obvious

加一点颜色可以增强对比

用颜色代表车流量



车流量



低

高

3rd Try, Python + D3 + Canvas

Shan He, @heshan_cheri

拼车



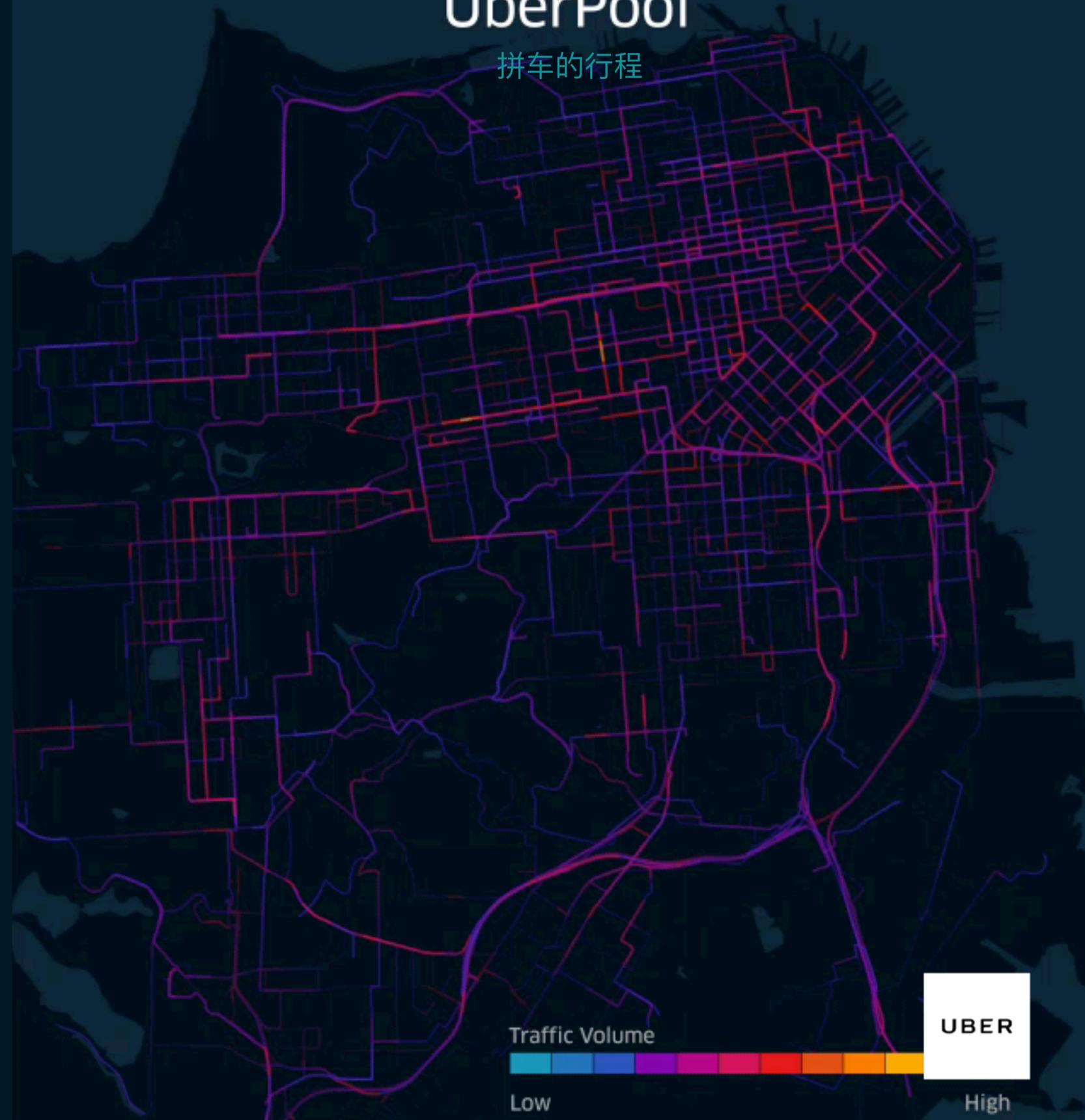
UBER

Design Tip: Add Motion

动态的图像更加生动

UberPool

拼车的行程



4th Try, animation

Shan He, @heshan_cheri

耗时2星期

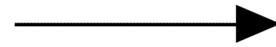
Dataset
数据上传

Data Processing
数据处理

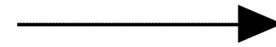
Visual Encoding
图像编码

Visualizations
生成可视化

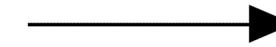
CSV
Json
Geojson



Python
Javascript

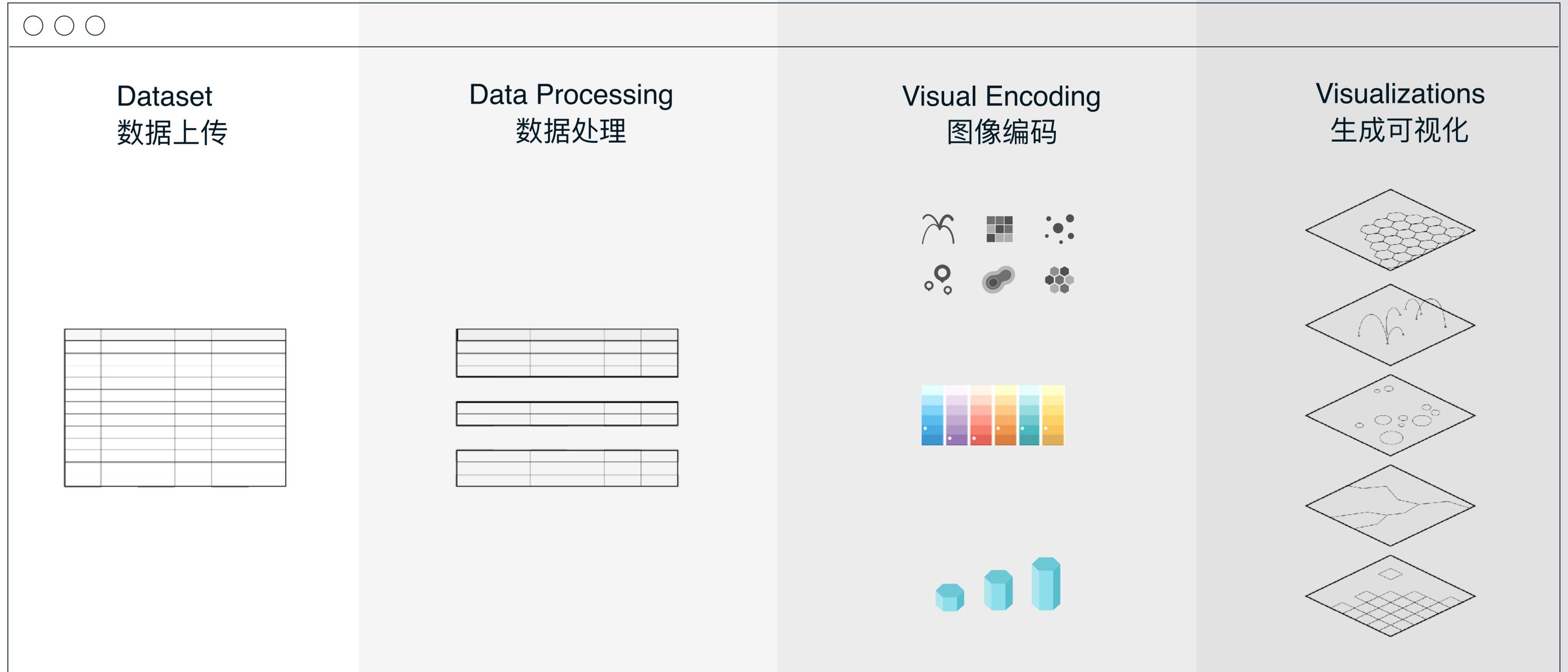


Motion
Color
Opacity



Scatterplot
Path
Animation

地理数据可视化的基本步骤



We built **Kepler.gl** for fast visual exploration of millions of geospatial data in the browser.

kepler.gl是用来快速生成地理数据可视化的前端工具

UBER

kepler.gl

Kepler.gl是一个用于大规模地理定位数据集的可视化探索的工具包。
kepler.gl是一个基于deck.gl的React组件。

React, Redux 组件

WebGL渲染

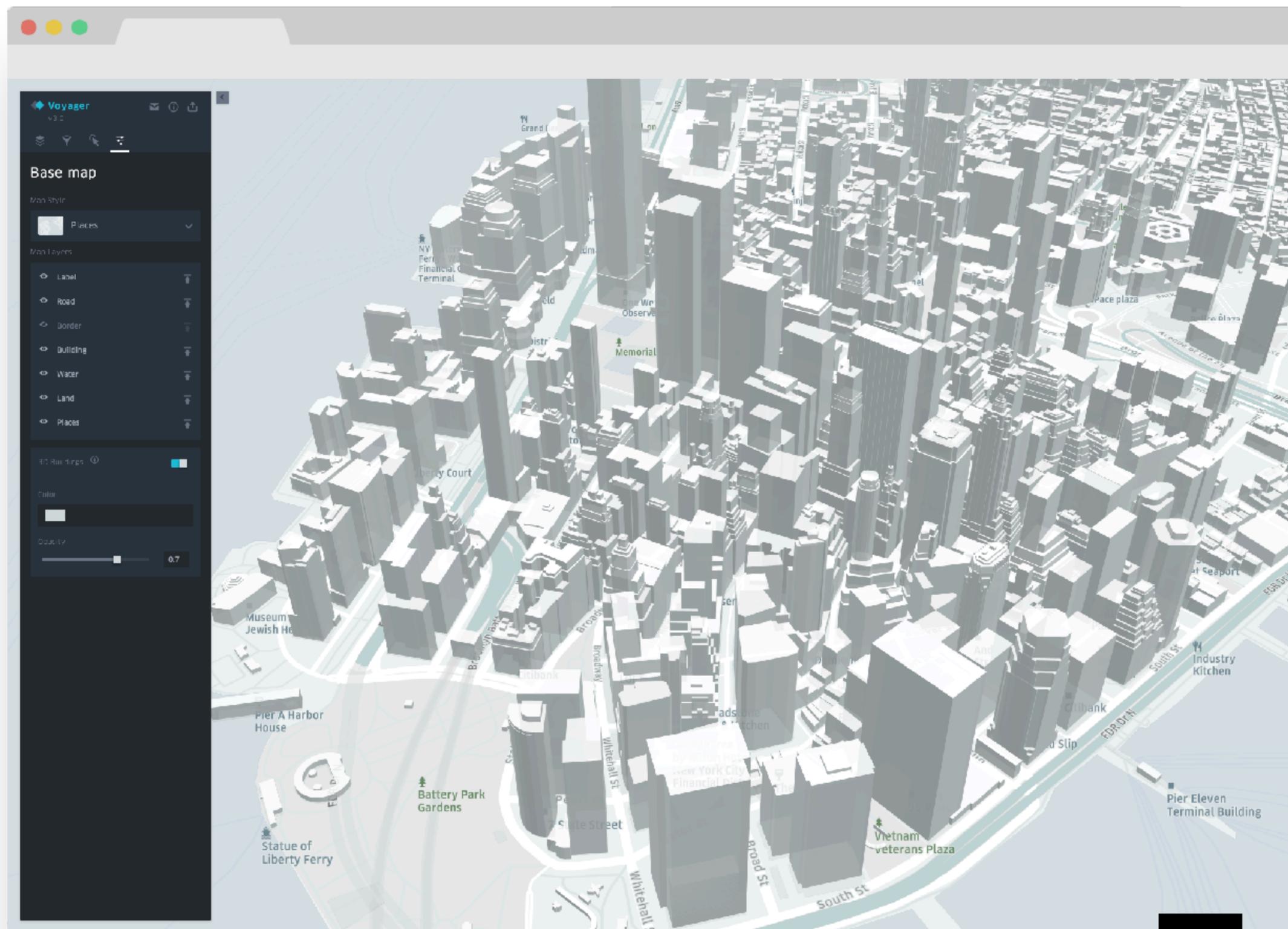
GPU计算

自带可视化图层和过滤功能

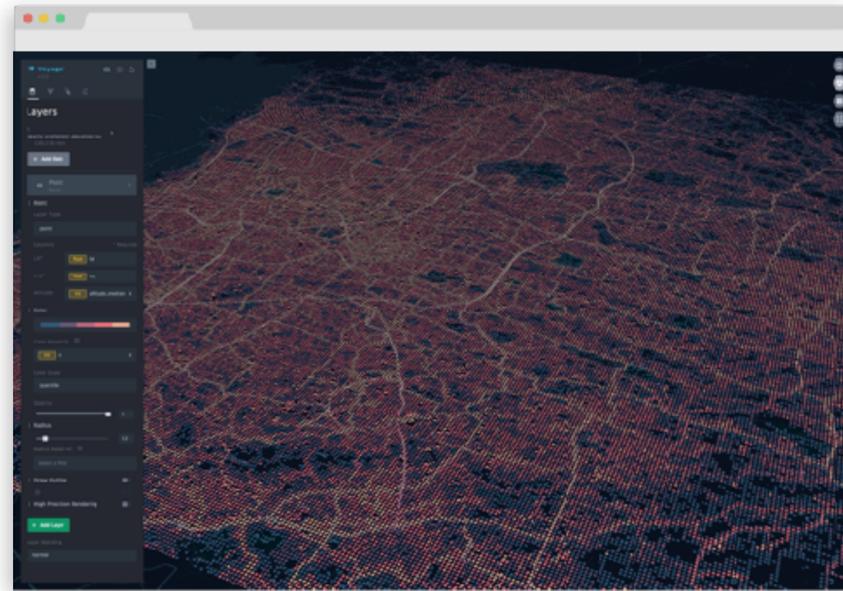
支撑从数据到图形的多维转换

全部前端数据处理

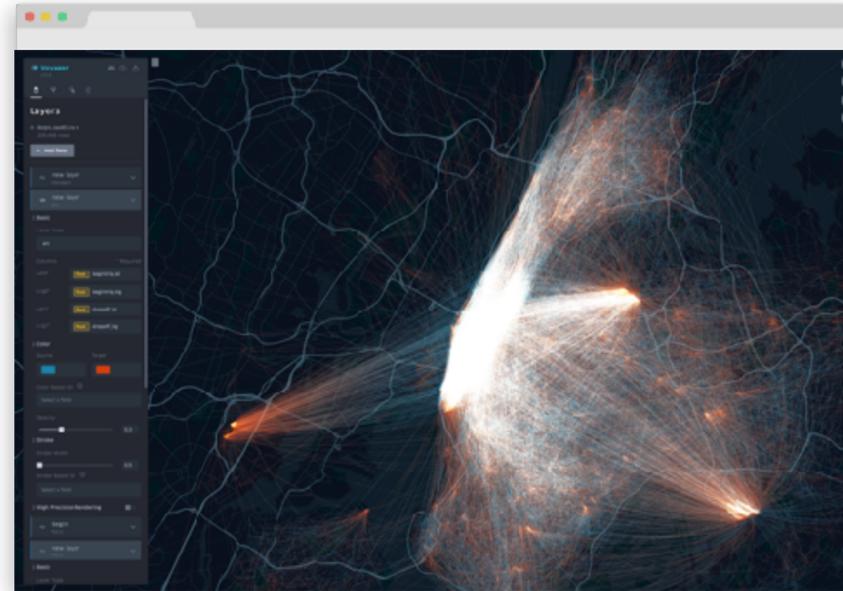
多功能交互体验



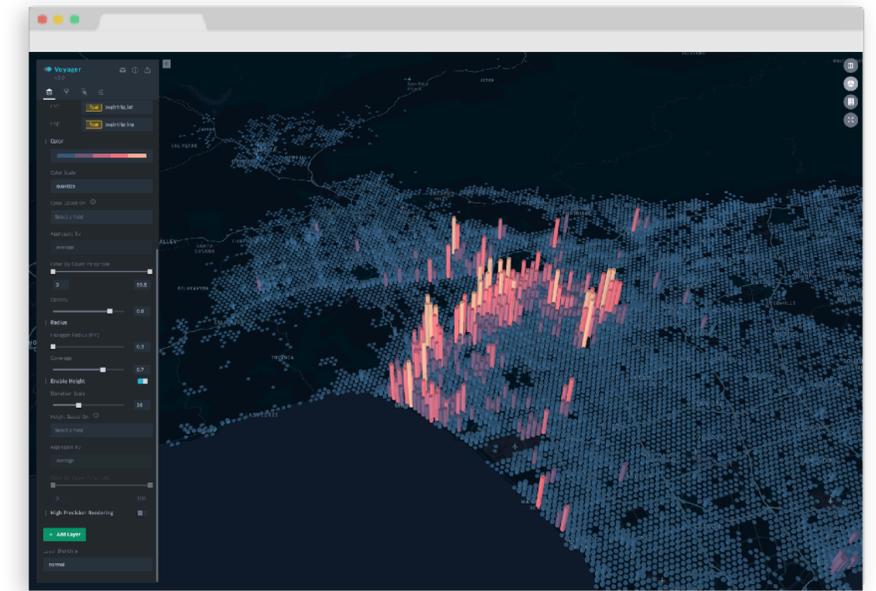
Photoshop式的可视化图层生成



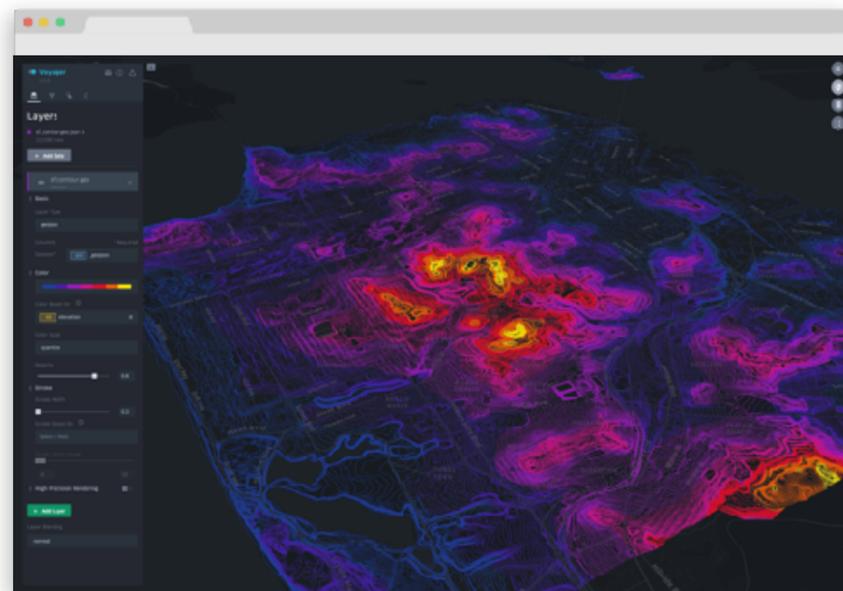
Point



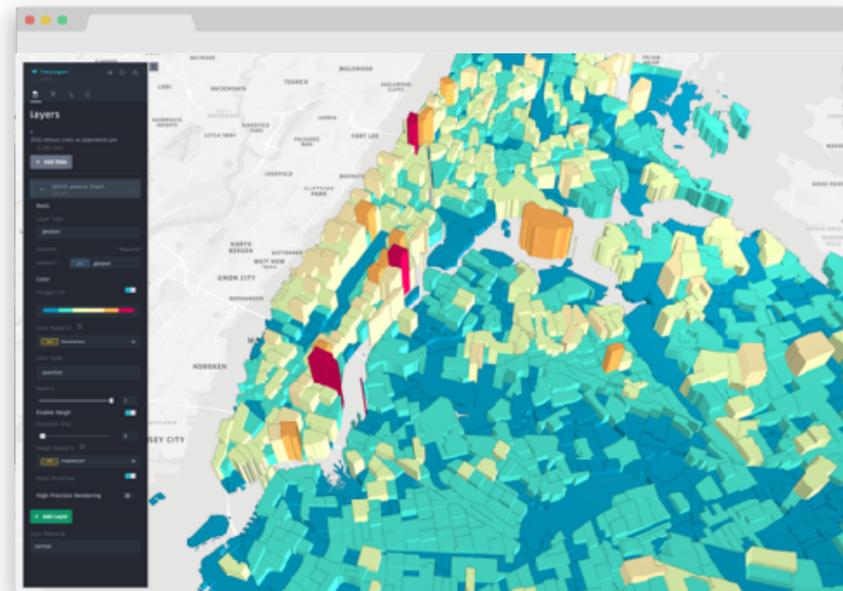
Arc



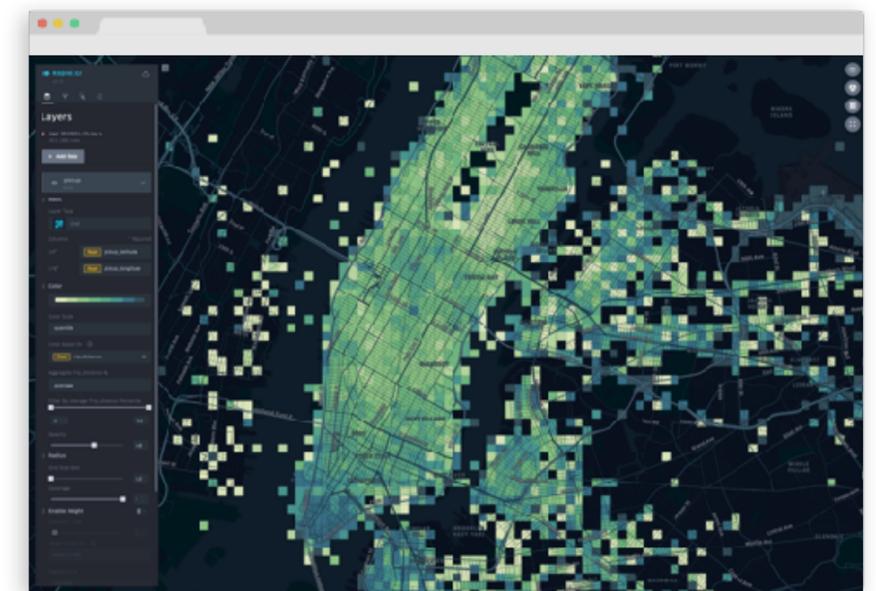
Hexbin



Path



Extruded Polygon



Grid

1. 拖拽式数据上传

CSV格式文件

| id | pickup_datetime | dropoff_datetime | trip_distance | begintrip_latitude | begintrip_longitude | dropoff_latitude | dropoff_longitude | fare_amount |
|----|----------------------------|----------------------------|---------------|--------------------|---------------------|------------------|-------------------|-------------|
| 1 | 2017-01-15 19:05:39 +00:00 | 2017-01-15 19:23:42 +00:00 | 1.59 | 37.778564 | -122.39096 | 37.37006 | -121.96353 | 12 |
| 2 | 2017-01-15 19:05:39 +00:01 | 2017-01-15 19:32:00 +00:00 | 2.38 | 37.78824 | -122.40894 | 37.418655 | -122.149734 | 16.5 |
| 3 | 2017-01-15 19:05:40 +00:00 | 2017-01-15 19:21:00 +00:00 | 2.83 | 38.281445 | -122.29453 | 37.787052 | -122.41089 | 12.5 |
| 4 | 2017-01-15 19:05:40 +00:00 | 2015-01-15 19:28:18 +00:00 | 8.33 | 37.79354 | -122.40121 | 37.780136 | -122.40495 | 26 |
| 5 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:20:36 +00:00 | 2.37 | 37.456535 | -122.136795 | 37.753033 | -122.42929 | 11.5 |
| 6 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:20:22 +00:00 | 7.13 | 37.40066 | -122.10239 | 37.749577 | -122.41829 | 21.5 |
| 7 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:31:00 +00:00 | 3.6 | 37.77118 | -122.42459 | 37.786648 | -122.401634 | 17.5 |
| 8 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:10:22 +00:00 | 0.89 | 37.879066 | -122.26108 | 38.122818 | -122.25759 | 5.5 |
| 9 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:10:55 +00:00 | 0.96 | 37.775578 | -122.39363 | 37.788277 | -122.40152 | 5.5 |
| 10 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:12:36 +00:00 | 1.25 | 37.7892 | -122.408966 | 37.876453 | -122.270096 | 6.5 |
| 11 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:22:11 +00:00 | 2.11 | 37.779964 | -122.40398 | 37.61695 | -122.38396 | 11.5 |
| 12 | 2017-01-15 19:05:41 +00:00 | 2017-01-15 19:14:05 +00:00 | 1.15 | 37.792385 | -122.406494 | 37.80718 | -122.40902 | 7.5 |
| 13 | 2017-01-15 19:05:42 +00:00 | 2017-01-15 19:16:18 +00:00 | 1.53 | 37.791046 | -122.401855 | 37.751713 | -122.42713 | 9 |
| 14 | 2017-01-15 19:05:42 +00:00 | 2017-01-15 19:49:07 +00:00 | 18.06 | 37.769897 | -122.41168 | 37.75977 | -122.41924 | 52 |
| 15 | 2017-01-15 19:05:42 +00:00 | 2017-01-15 19:18:33 +00:00 | 1.76 | 37.798237 | -122.41889 | 37.80641 | -122.404816 | 10 |
| 16 | 2017-01-15 19:05:42 +00:00 | 2017-01-15 19:21:40 +00:00 | 5.19 | 37.76018 | -122.41097 | 37.751354 | -122.43317 | 17.5 |

时间格式

地理格式

其他



Add Data To Map



Uploading...sf_trips.csv...
Drag & Drop Your File(s) Here
or [browse your files](#)

*Chrome user: Limit file size to 250mb, if need to upload larger file, try Safari



2. 数据过滤和交互



Layers

sf_trips.csv >
184,900 rows

+ Add Data

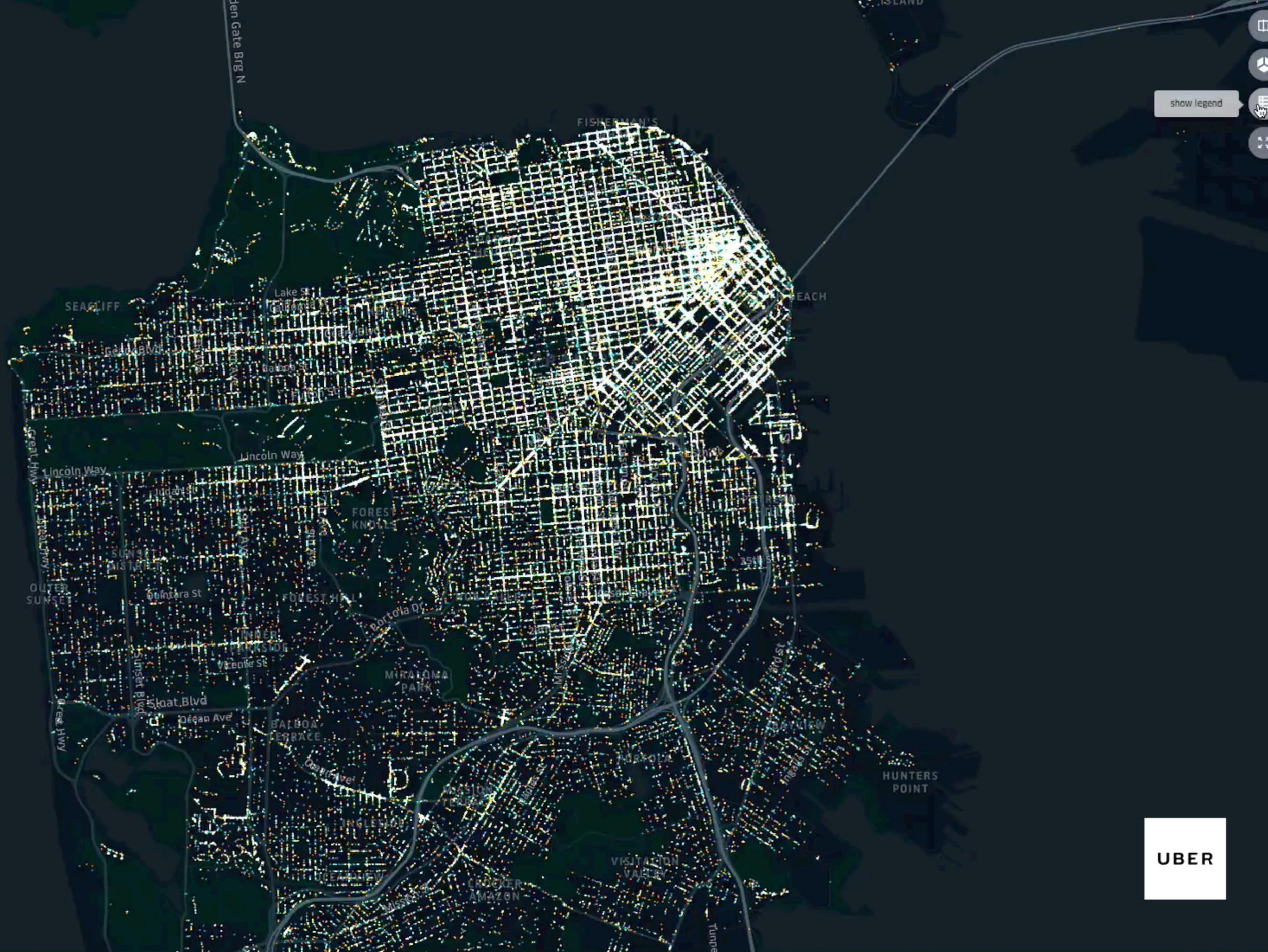
begintrip
Point

dropoff
Point

+ Add Layer

Layer Blending

additive





Interactions

Tooltip

Brush

Layer Legend

- begintrip**
Point color
█
- dropoff**
Point color
█
- Trip Arc**
Arc color
█



4. 前端集成计算



Layers

sf_trips.csv >
184,900 rows

+ Add Data

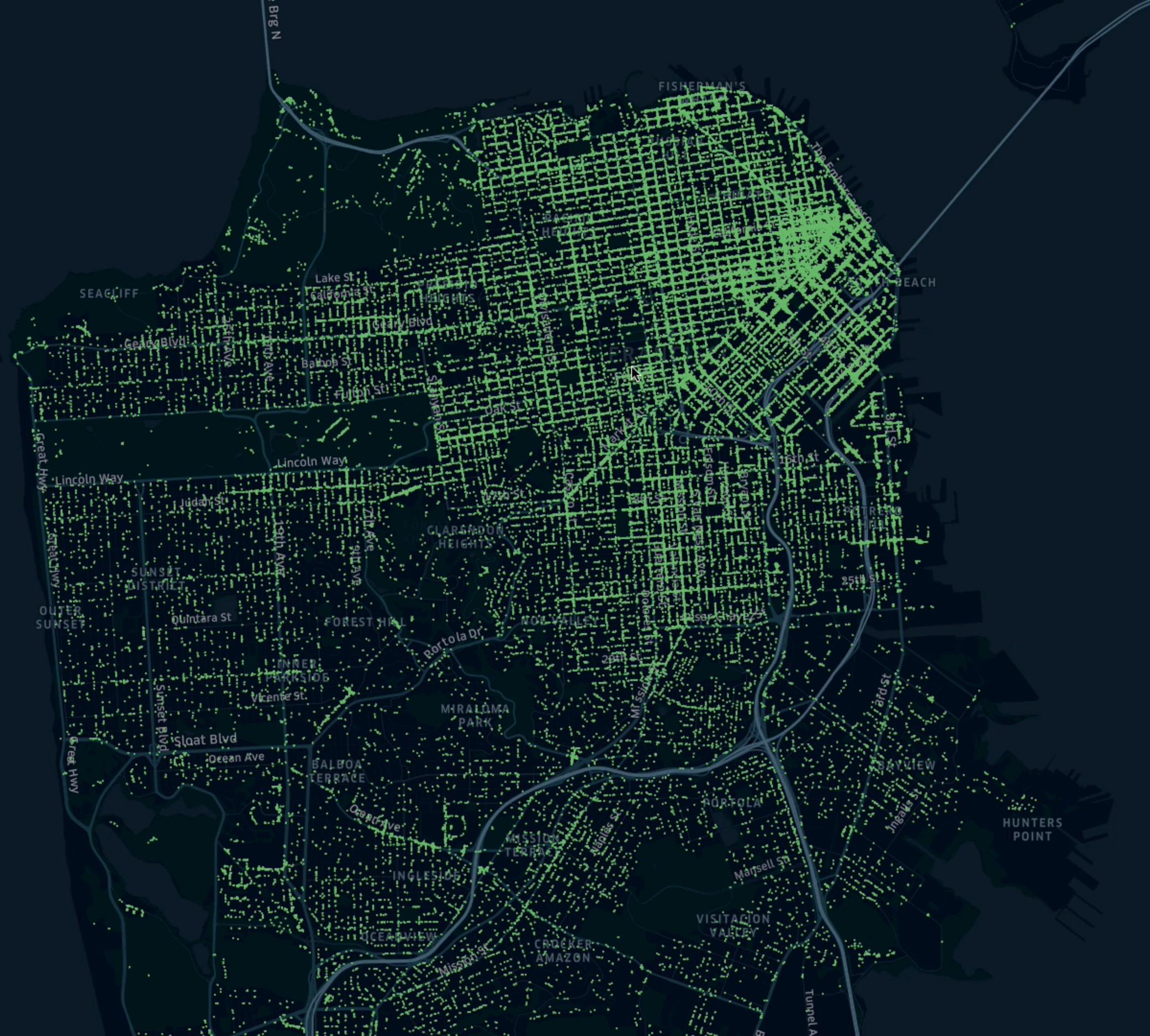
begintrip
Point

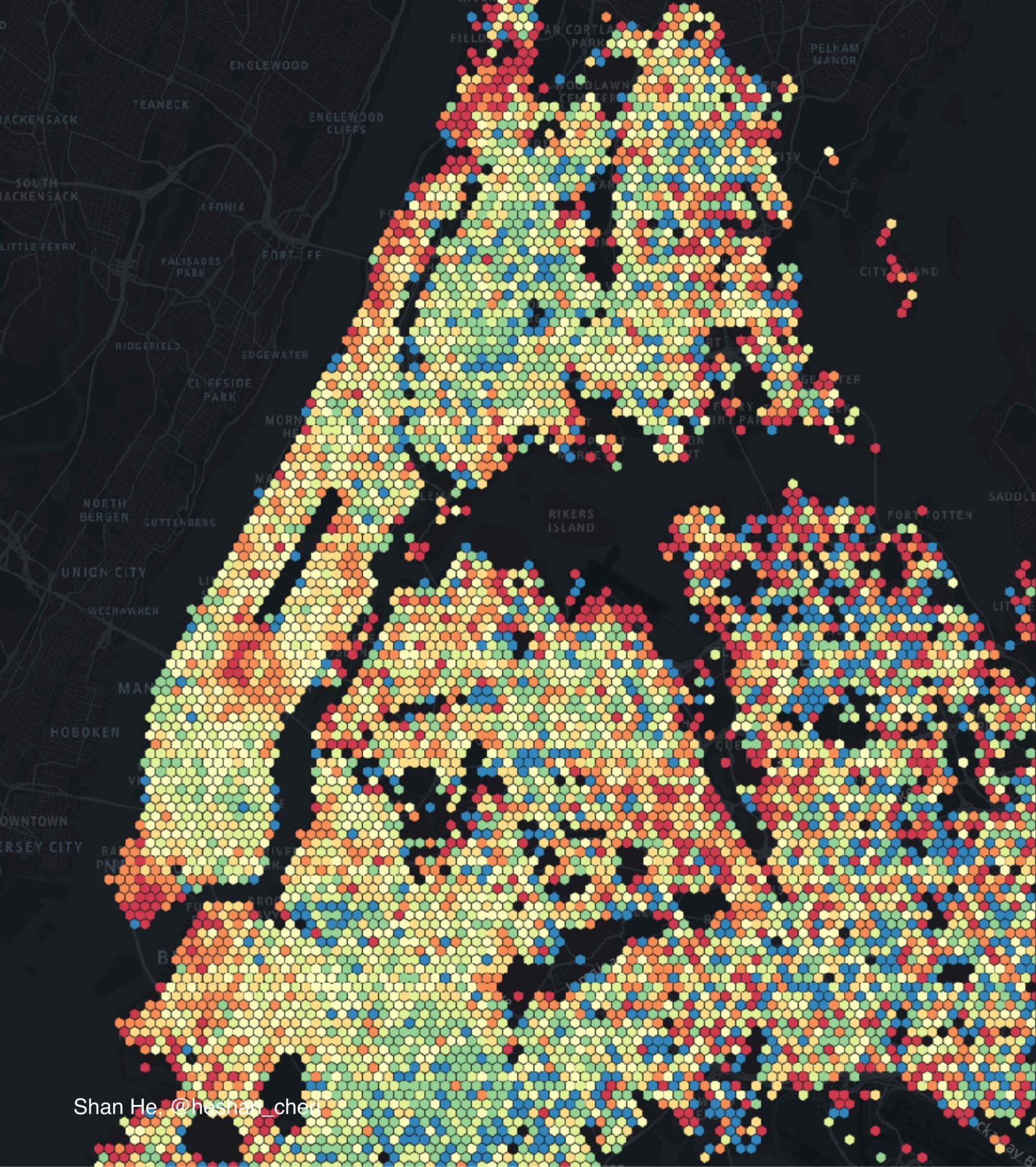
dropoff
Point

+ Add Layer

Layer Blending

normal





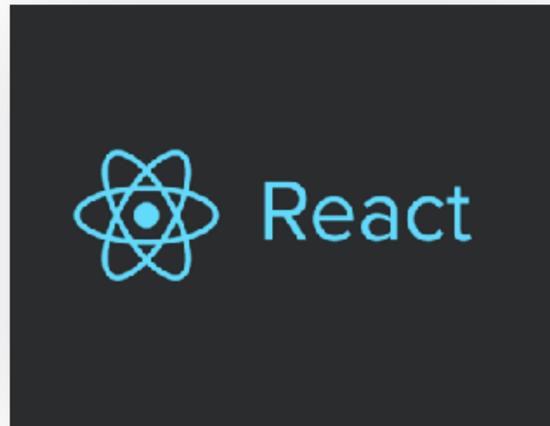
Shan He, @heshan_cherl



Behind Kepler.gl

Tech Stacks

前端地理数据可视化组件



React + Redux

A javascript library for building component based user interfaces.



Mapbox GL

An open-source libraries for creating highly customizable and responsive client-side maps.



uber/react-map-gl

react-map-gl provides a React friendly API wrapper around Mapbox GL JS. A webGL based vector tile mapping library.



uber/deck.gl

A WebGL overlay suite for React providing a set of highly performant data visualization overlays.

WebGL

Mapbox GL

React-map-gl

Deck.gl

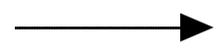
Luma.gl

Kepler.gl



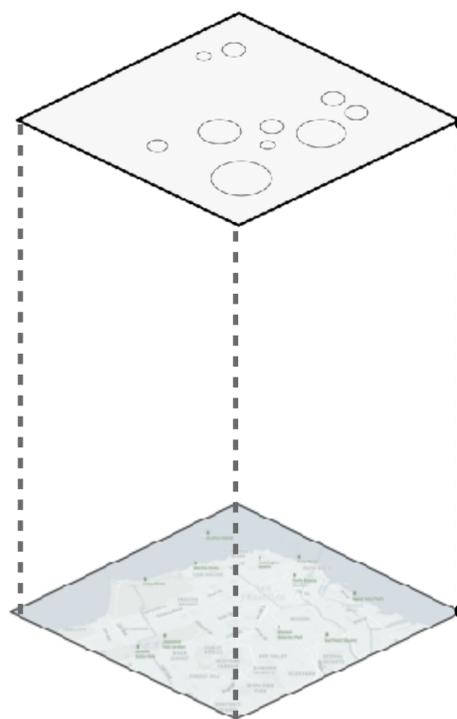
React + WebGL 地理数据可视化

数据



图形

地图



REACT-MAP-GL

React components for Mapbox GL JS

GET STARTED

DECK.GL

Large-scale WebGL-powered Data Visualization

GET STARTED

LUMA.GL

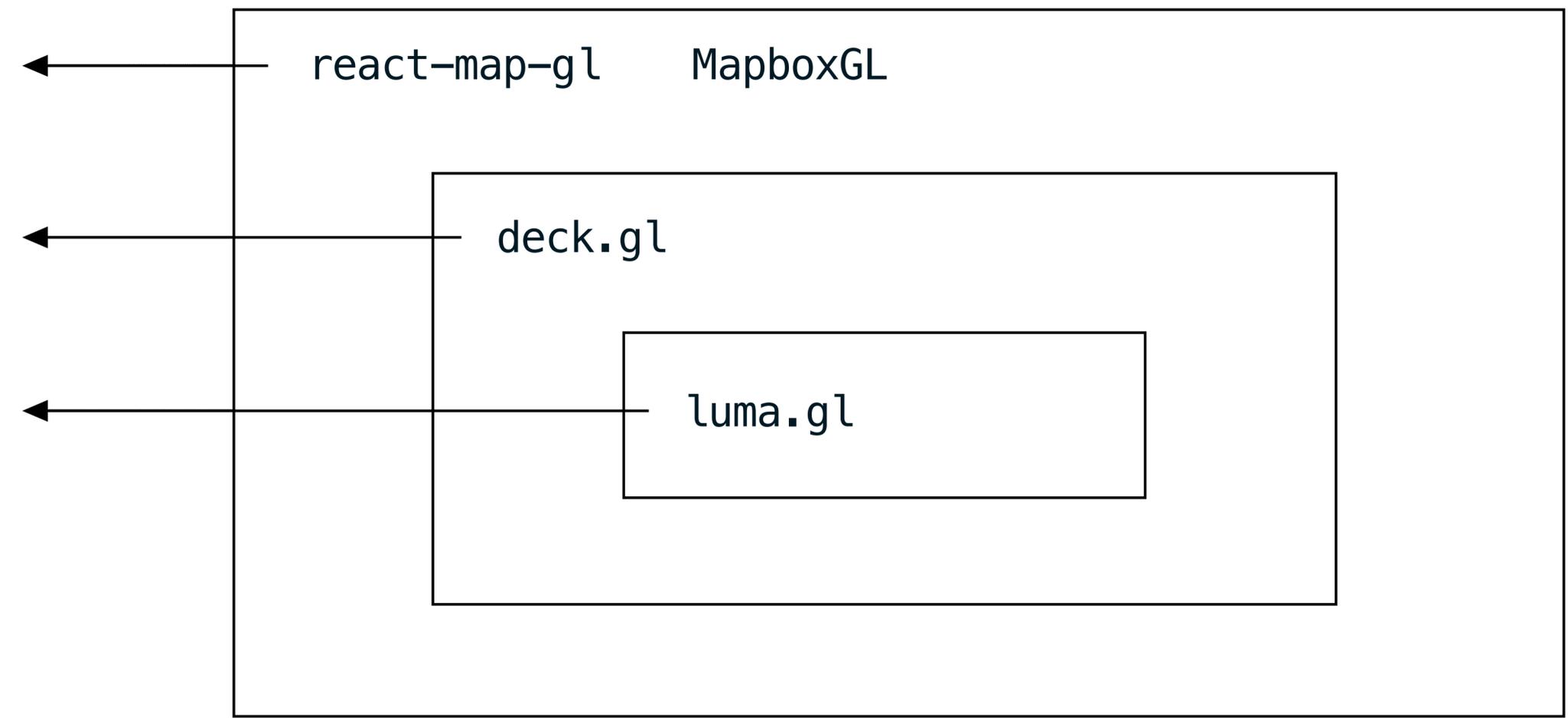
A WebGL-powered Framework for GPU-based Visualization and Computation

GET STARTED

React地图组件

WebGL可视化图层

WebGL数据绑定



```

import DeckGL, {ScatterplotLayer} from 'deck.gl';
import React, {Component} from 'react';
import ReactMapGL from 'react-map-gl';

class MyMap extends Component {

  render() {
    const {viewport, points} = this.props;

    const layers = [
      new ScatterplotLayer({
        id: 'scatterplot',
        data: points,
        getPosition: d => ([d.longitude, d.latitude]),
        onHover: this._onHover
      })
    ];

    <ReactMapGL
      mapboxAccessToken={MAPBOX_ACCESS_TOKEN}
      viewport={viewport}
      onViewportChange={this._onViewportChange}>
      <DeckGL
        {...viewport}
        layers={layers}/>
    </ReactMapGL>
  }
}

```

Kepler.GI Tech Stack

Data Flow

数据流

Redux

**State
Transition**

UI Rendering

渲染组建

React

PF Component

Map Rendering

地图渲染

Deck.gl

React-map-gl

MapboxGL

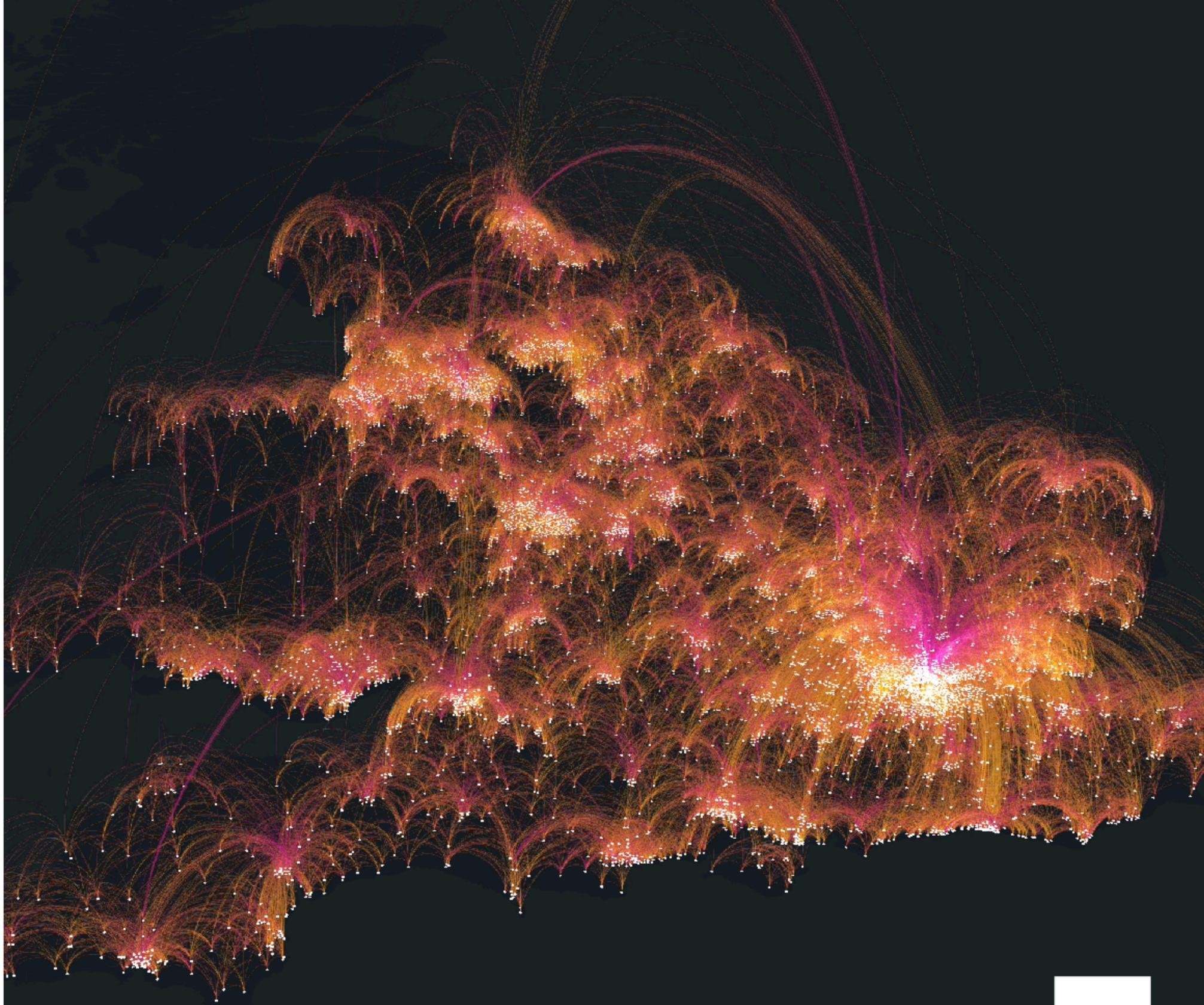
GPU Computing

GPU运算

Map projection
地图投影

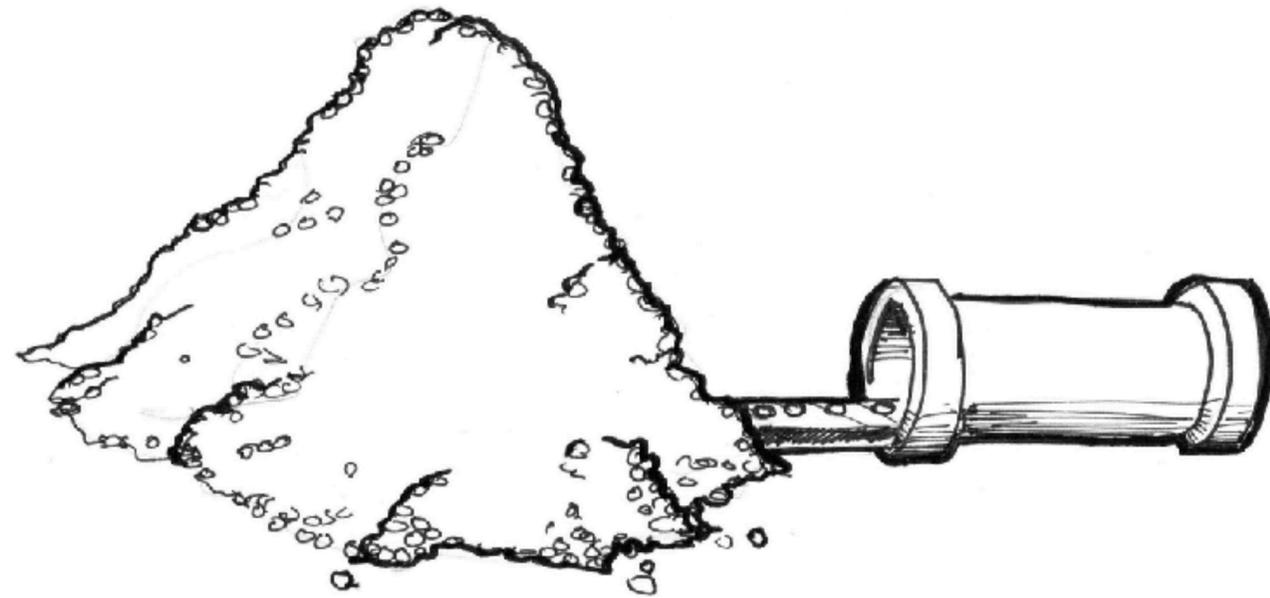
Data Filtering
数据过滤

Interaction Event
交互事件



CPU

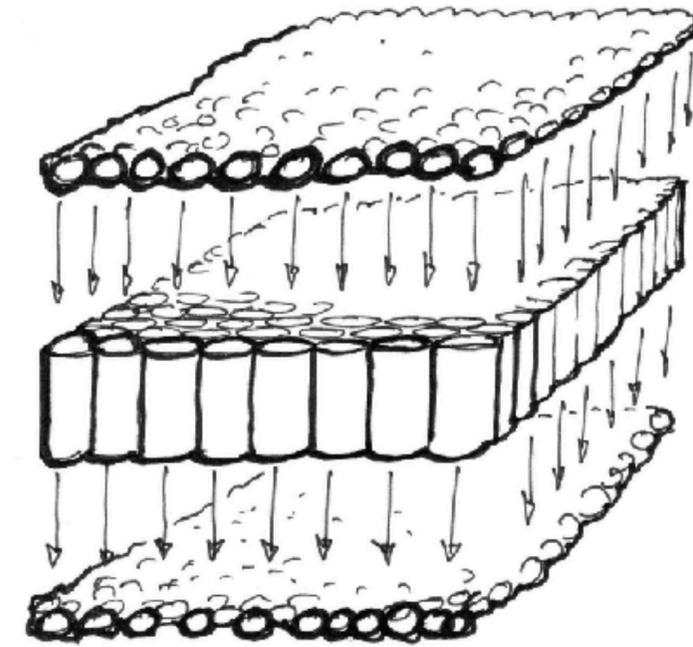
Central Processing Unit



Single Thread Processing
单线程处理

GPU

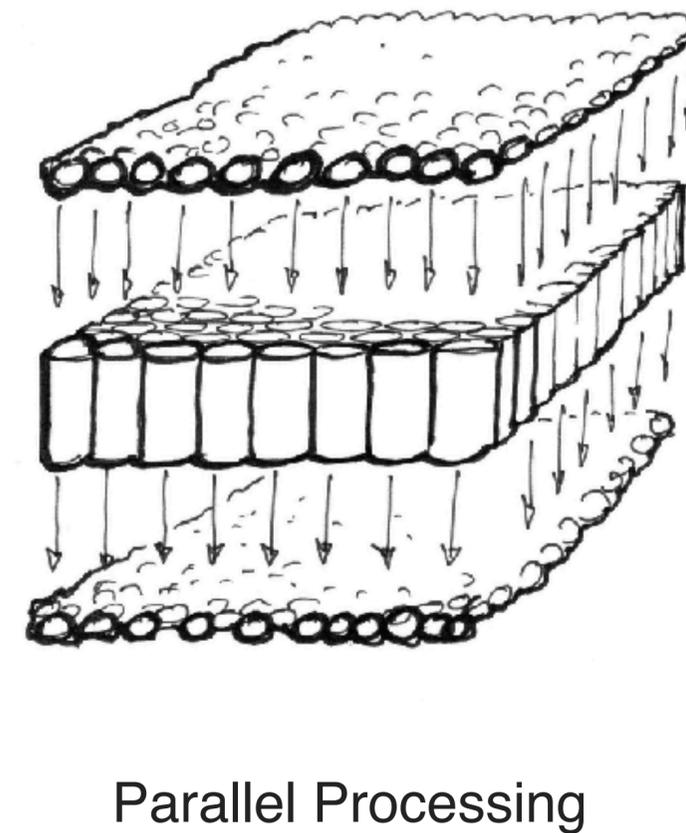
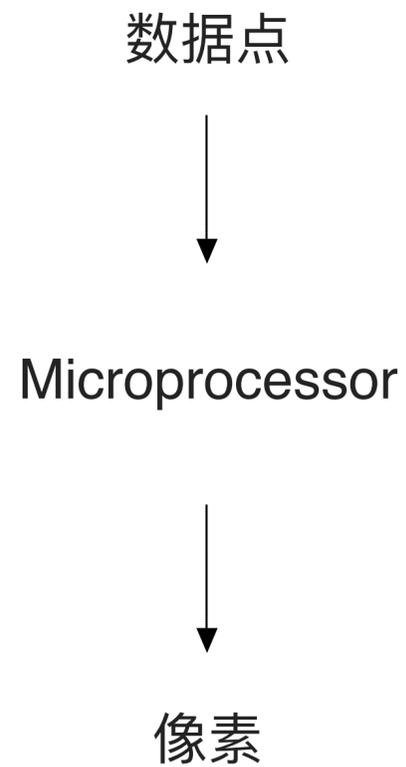
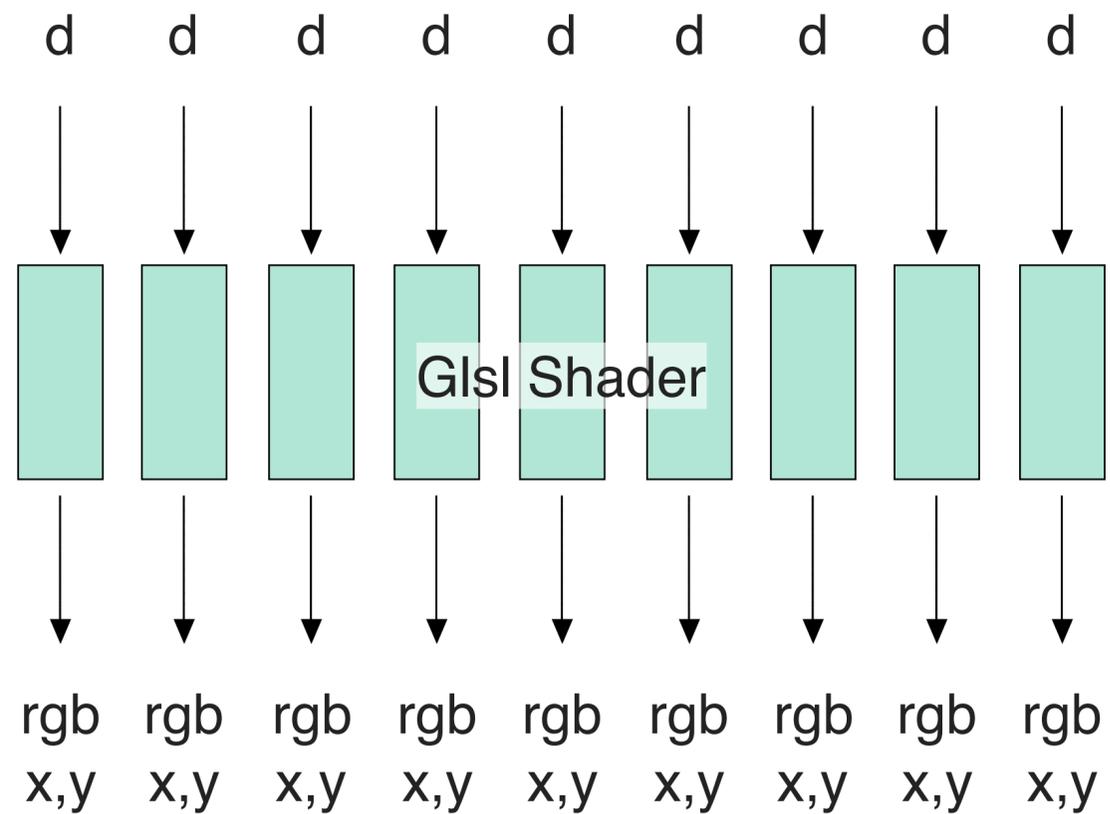
Graphic Processing Unit



Parallel Processing
并列处理

数据可视化

GPU



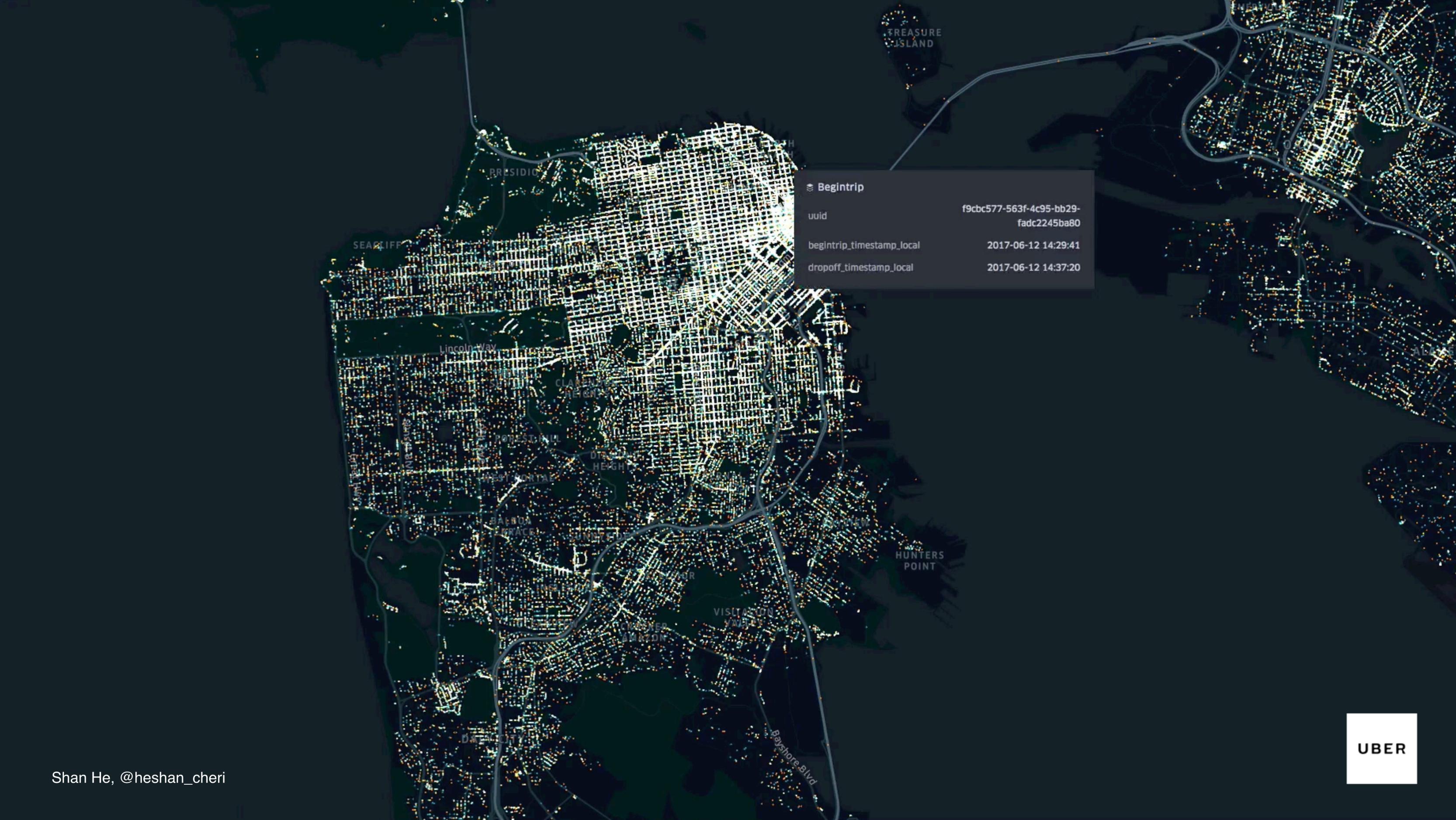
GPU Computing

GPU运算

Map Projection

地图投影





| | |
|---|--------------------------------------|
|  Begintrip | |
| uuid | f9cbc577-563f-4c95-bb29-fadc2245ba80 |
| begintrip_timestamp_local | 2017-06-12 14:29:41 |
| dropoff_timestamp_local | 2017-06-12 14:37:20 |



CPU

`Project` (points, viewport) => [`screenX`, `screenY`]

```
Project(lat, lng) => [x, y]
```

200,000 points
on every zoom, pan,
window resize

GPU

`Project` (points, viewport) => [`screenX`, `screenY`]

```
Project(lat, lng) => [x, y]
```

CPU

Javascript

```
const screenXY =  
  project([lat, lng], viewport);
```

GPU

GLSL Shaders

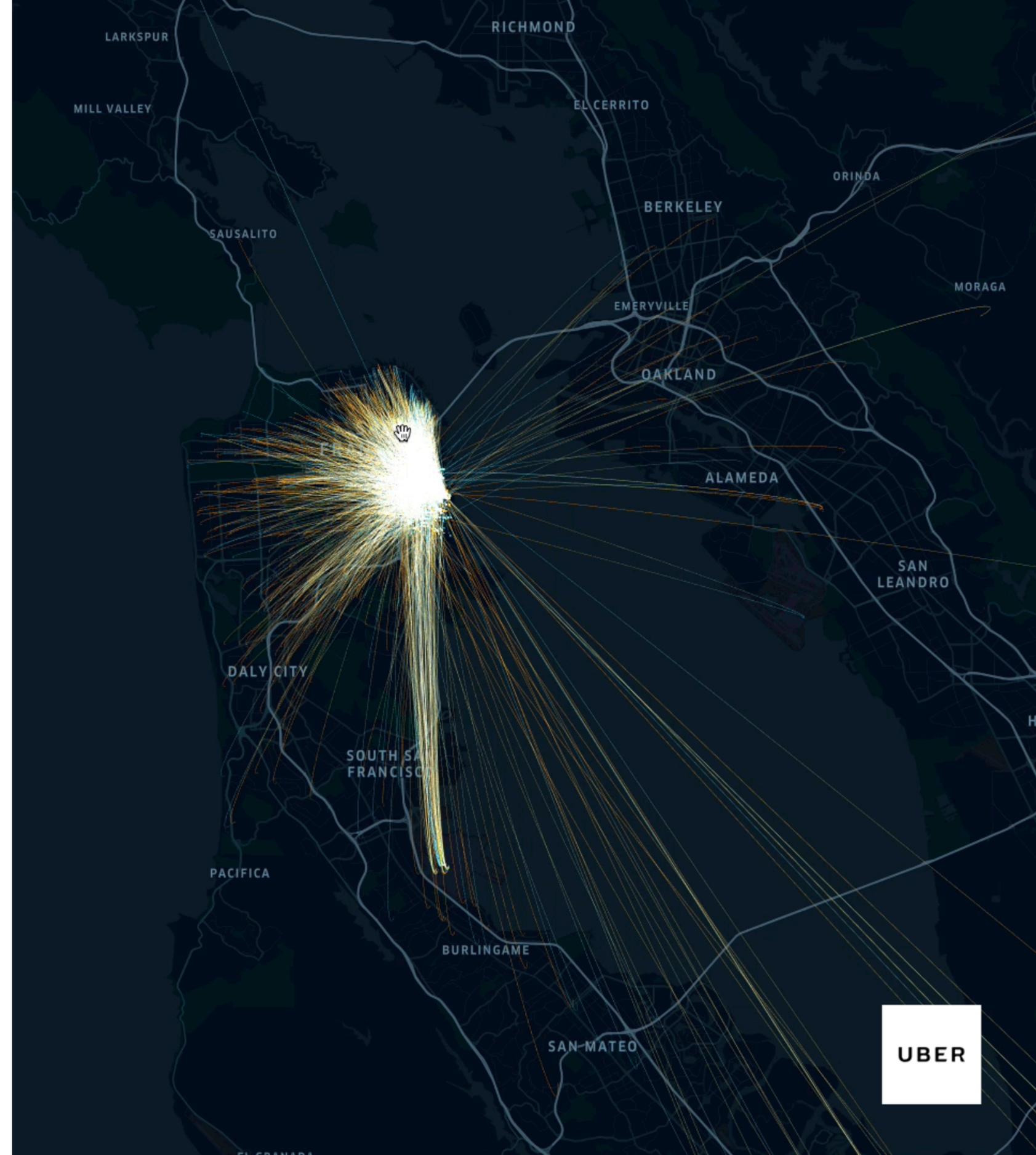
```
uniform mat4 viewport;  
attribute vec4 instancePosition;  
  
void main() {  
  
  gl_Position = project(  
    instancePositions,  
    viewport  
  );  
}
```

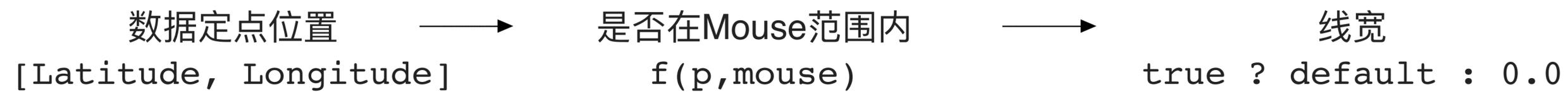
GPU Computing

GPU运算

Data Filtering
数据过滤

Interaction Event
交互事件





GLSL Shaders

```
uniform vec2 mousePos;
uniform float strokeWidth;
uniform float brushRadius;
attribute vec4 instancePosition;

float isPointInRange(vec2 latlng, vec2 mousePos, float brushRadius) {
    return float(distance(latlng, mousePos) <= brushRadius);
}

void main() {

    float isInBrush = isPointInRange(instancePositions.xy, brushSource);
    float width = mix(0.0, strokeWidth, isInBrush);

    vec4 position = project(instancePositions, viewport);
    gl_Position = position + vec4(width, 0.0, 0.0);

}
```

Redux-Connected Component

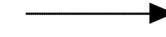
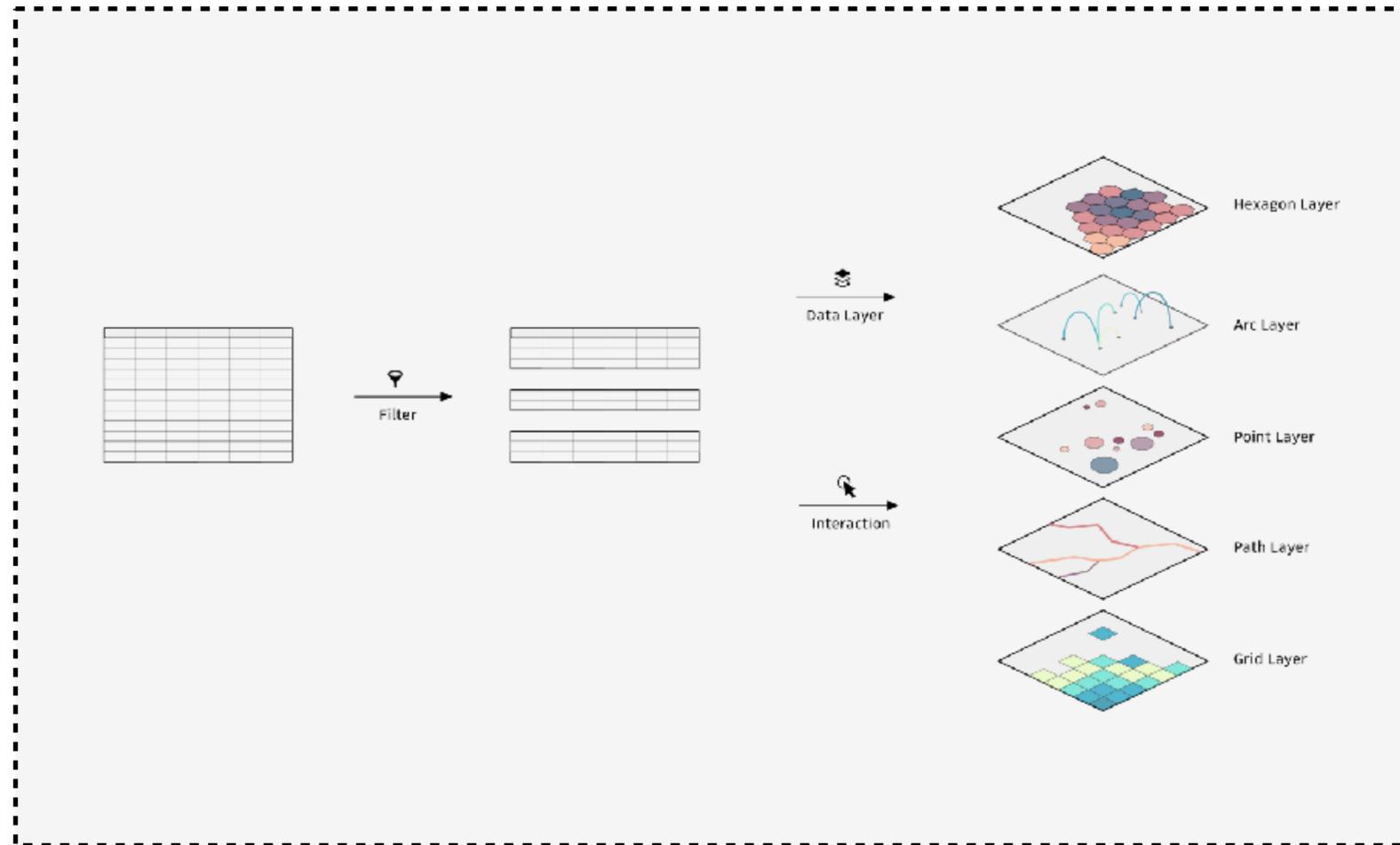
Redux-connected 组件

Kepler.gl is a redux-connected component

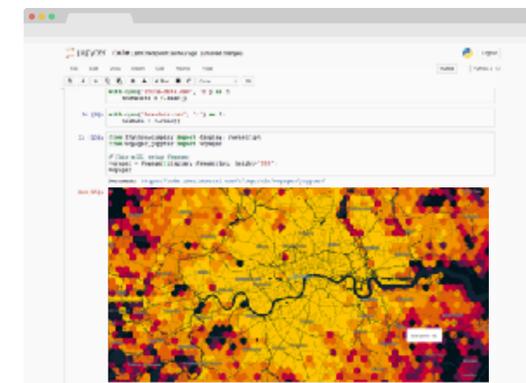
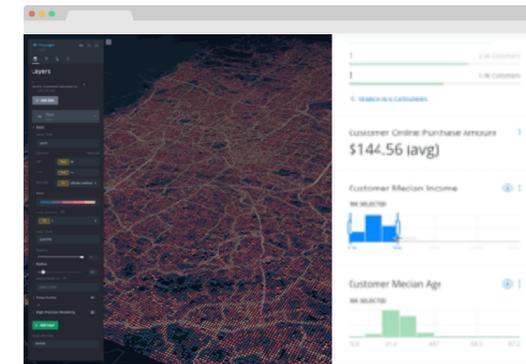
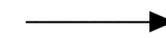
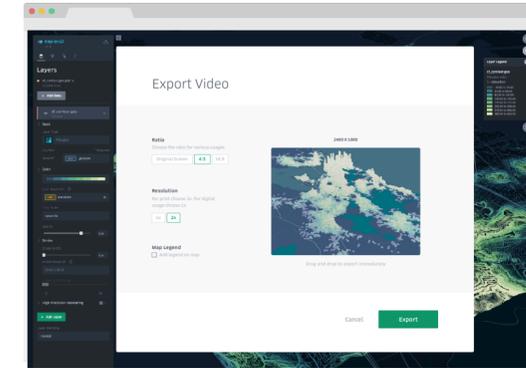
Import Kepler.gl Into other Apps

将kepler.gl输入到其他前端地图软件中

Kepler.gl

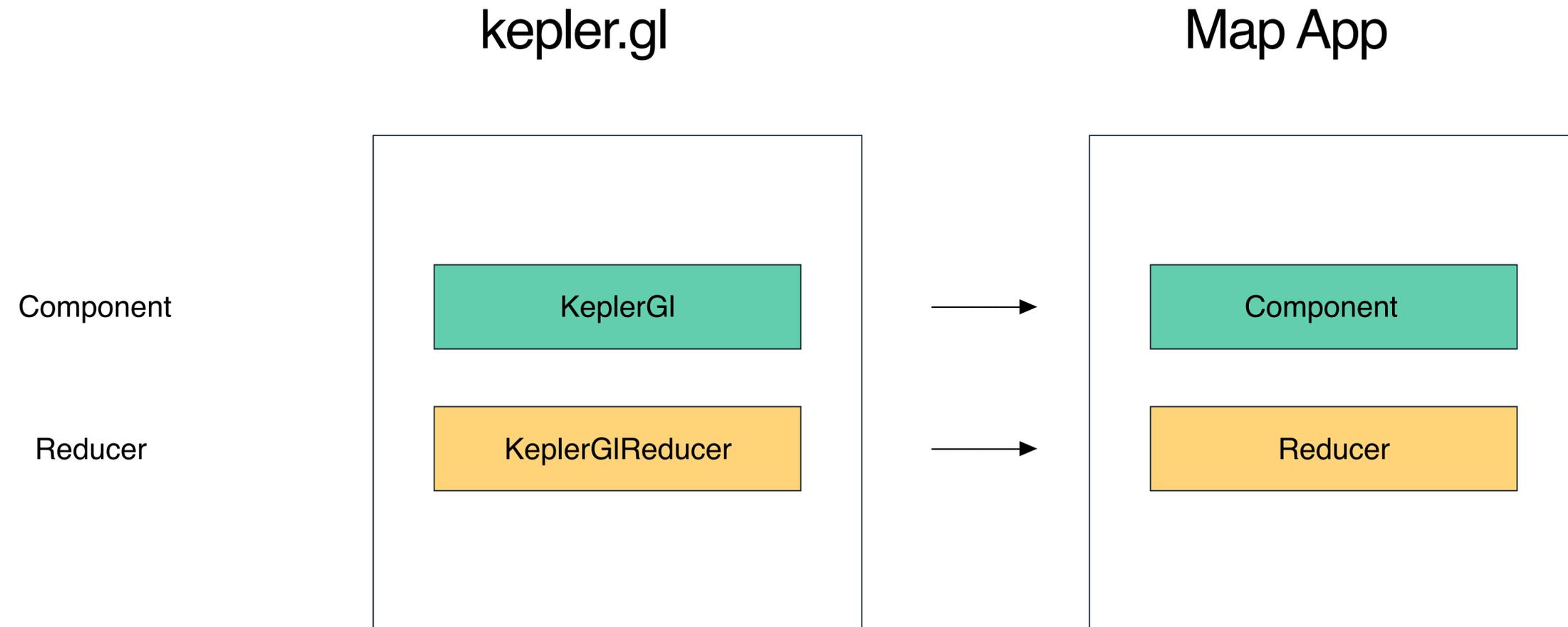


Other Map Apps



Kepler.gl is a redux-connected component

kepler.gl是一个redux-connected的组件



Mount kepler.gl

加载 [kepler.gl](#) 组件

```
import {combineReducers} from 'redux';
import keplerGLReducer from 'kepler.gl/reducers';

export default combineReducers({

  // mount keplerGl reducer
  keplerGl: keplerGLReducer,

  // other reducer
});
```

reducer

```
import React from 'react';
import KeplerGl from 'kepler.gl';

const Map = props => (
  <KeplerGl
    id="foo"
    width={width}
    height={height}
    mapboxAccessToken={token}
  />
);
```

component

Mount Multiple kepler.gl Components

加载多个 kepler.gl 组件

```
const Map2 = props => (  
  <div>  
    <KeplerGl  
      id="foo"  
      key="foo"  
    />  
    <KeplerGl  
      id="bar"  
      key="bar"  
    />  
  </div>  
);
```

Component
多个 kepler.gl 组件

```
forwardTo('foo', dispatch)  
───────────>  
  
forwardTo('bar', dispatch)  
───────────>
```

Forward Dispatch
派遣Dispatch

```
state = {  
  keplerGl: {  
    foo: {...},  
    bar: {...},  
  }  
}
```

Reducer

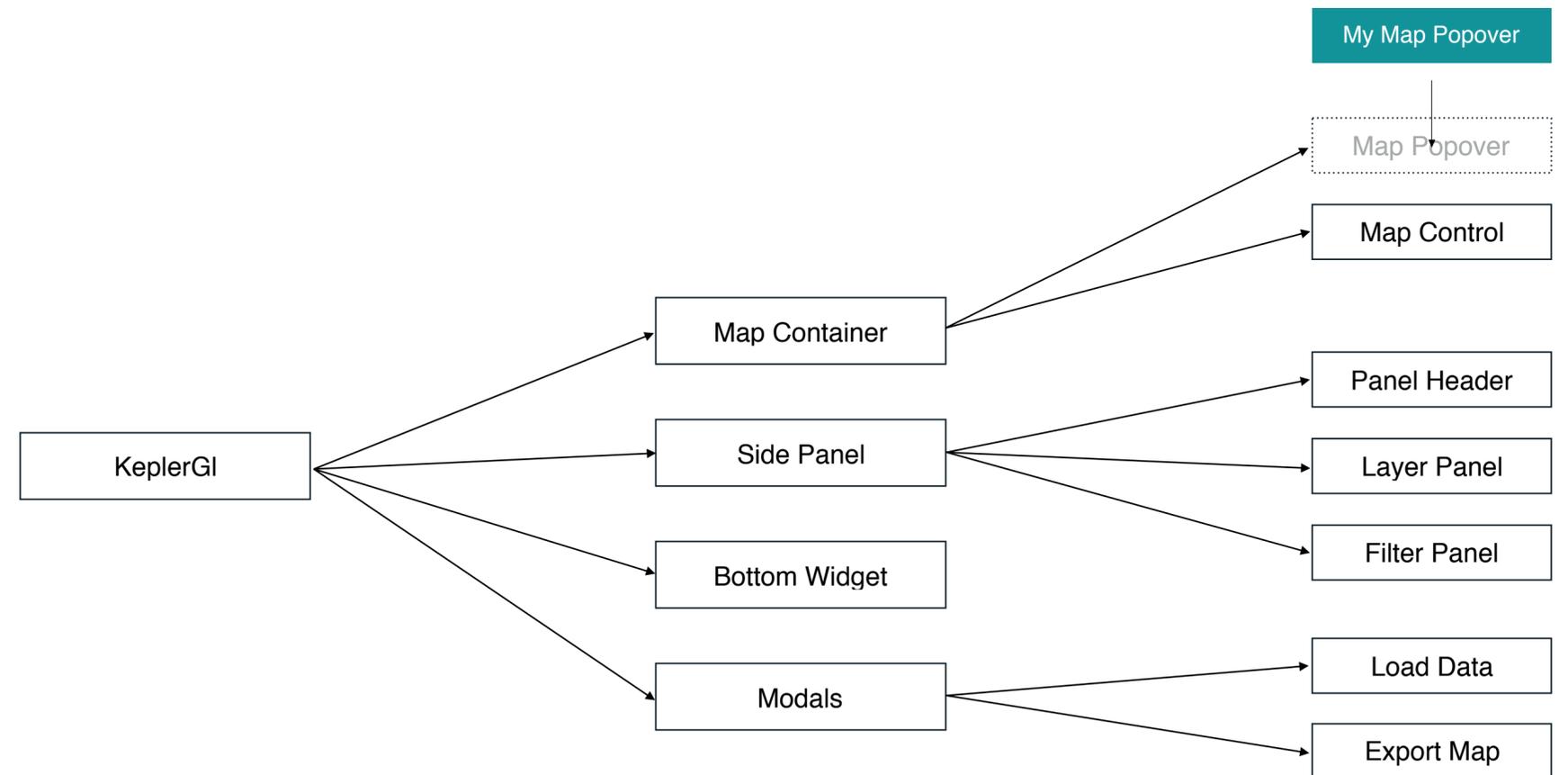


```
return (state = initialCoreState, action) => {  
  
  // update child states  
  Object.keys(state).forEach(id => {  
    const updateItemState = coreReducer(state[id], actionFor(id, action));  
    state = updateProperty(state, id, updateItemState);  
  });  
  
  // perform additional state reducing (e.g. switch action.type etc...)  
  return handleActions(  
    {  
      [REGISTER_ENTRY]: handleRegisterEntry,  
      [DELETE_ENTRY]: handleDeleteEntry,  
      [RENAME_ENTRY]: handleRenameEntry  
    },  
    initialCoreState  
  )(state, action);  
};
```

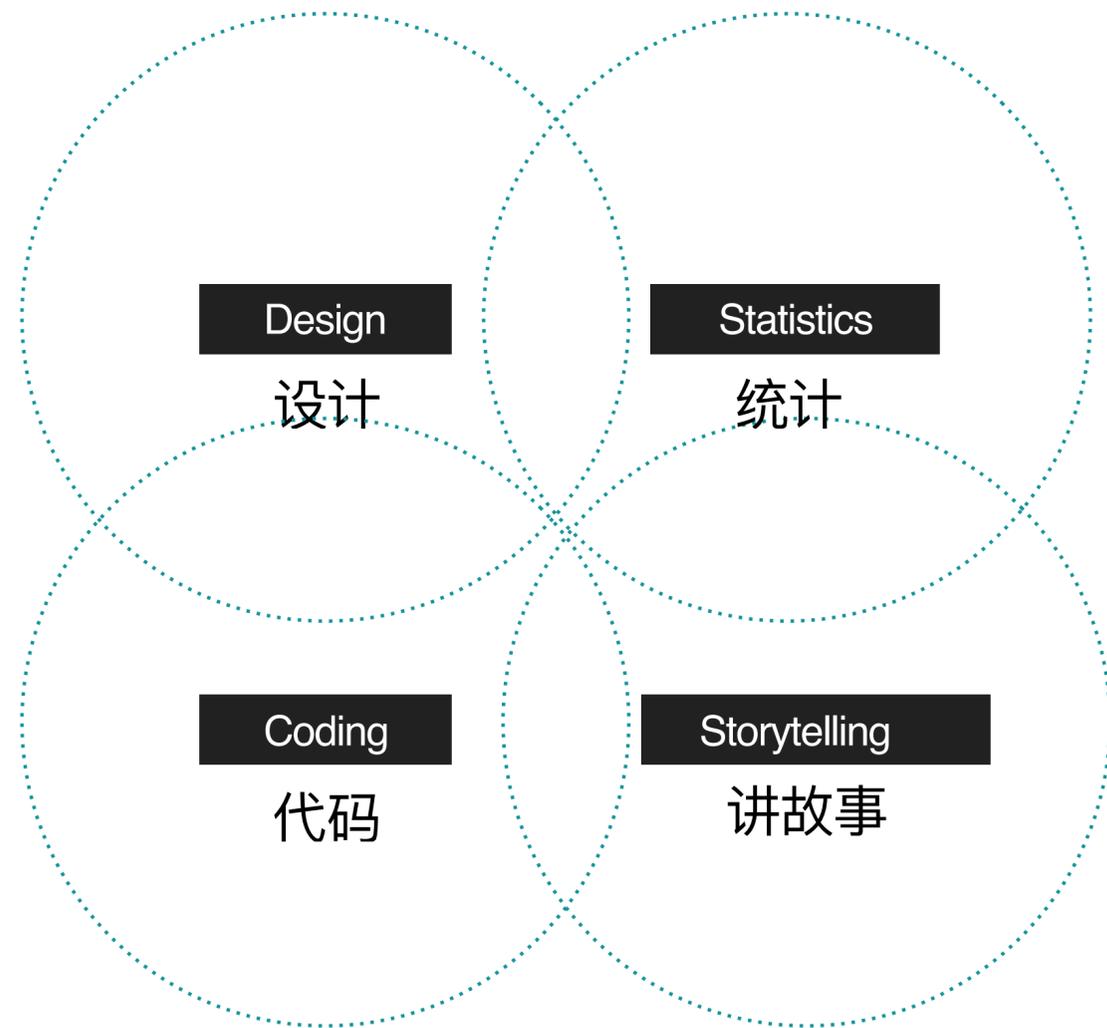
Other Techniques

Component Dependency Injection
组件依赖注入

Local Selector
局部选择器



Summarize



About Us

35 People

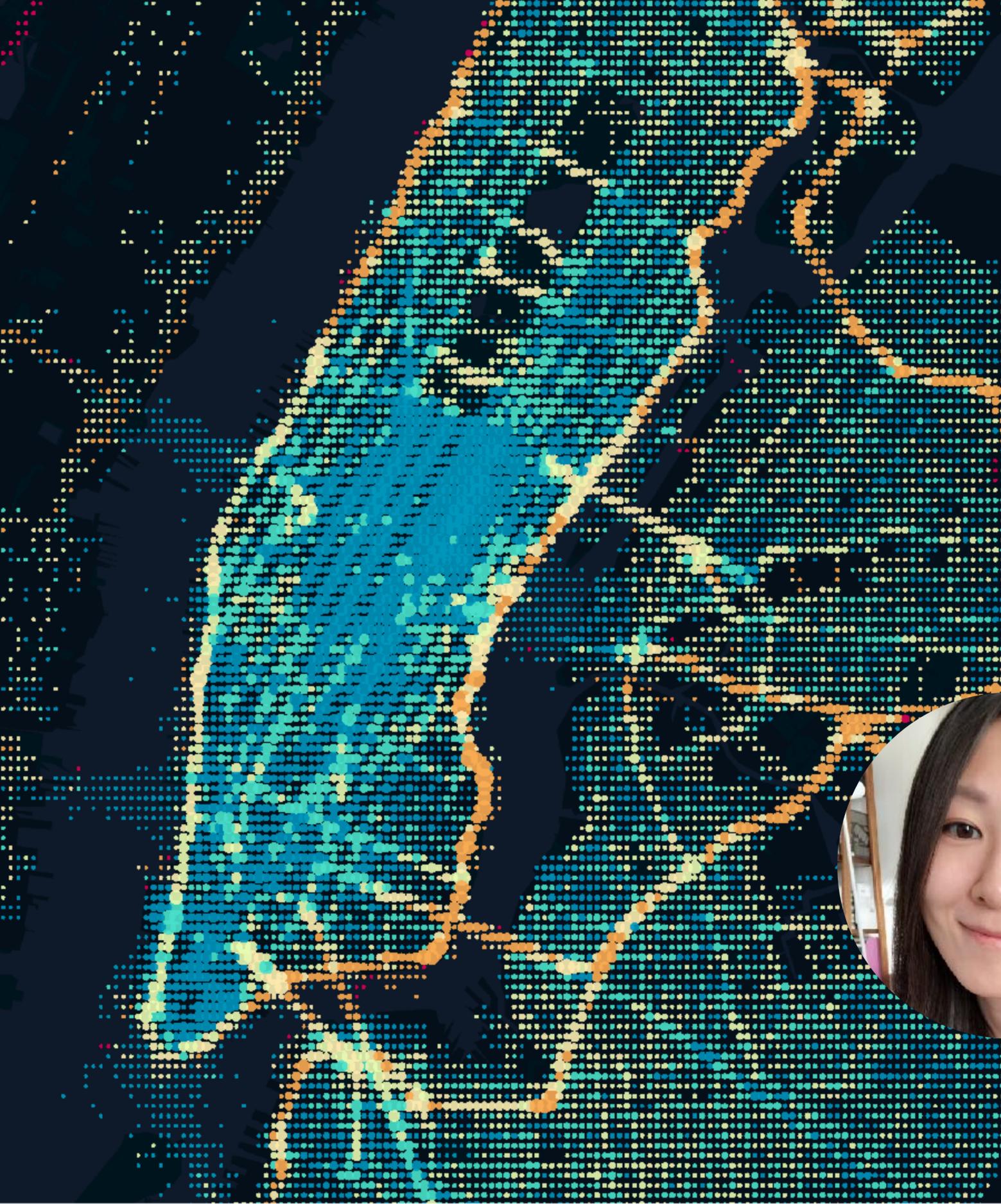
Front End
前端开发

Computer Graphics
电脑图形学

UI / UX Design
平面用户体验设计

Information Design
信息设计





Shan He

Senior Data Visualization Engineer
Uber

[@heshan_cheri](#)

