Mapping and Navigating in a Hectic World

Xiaofeng Ren

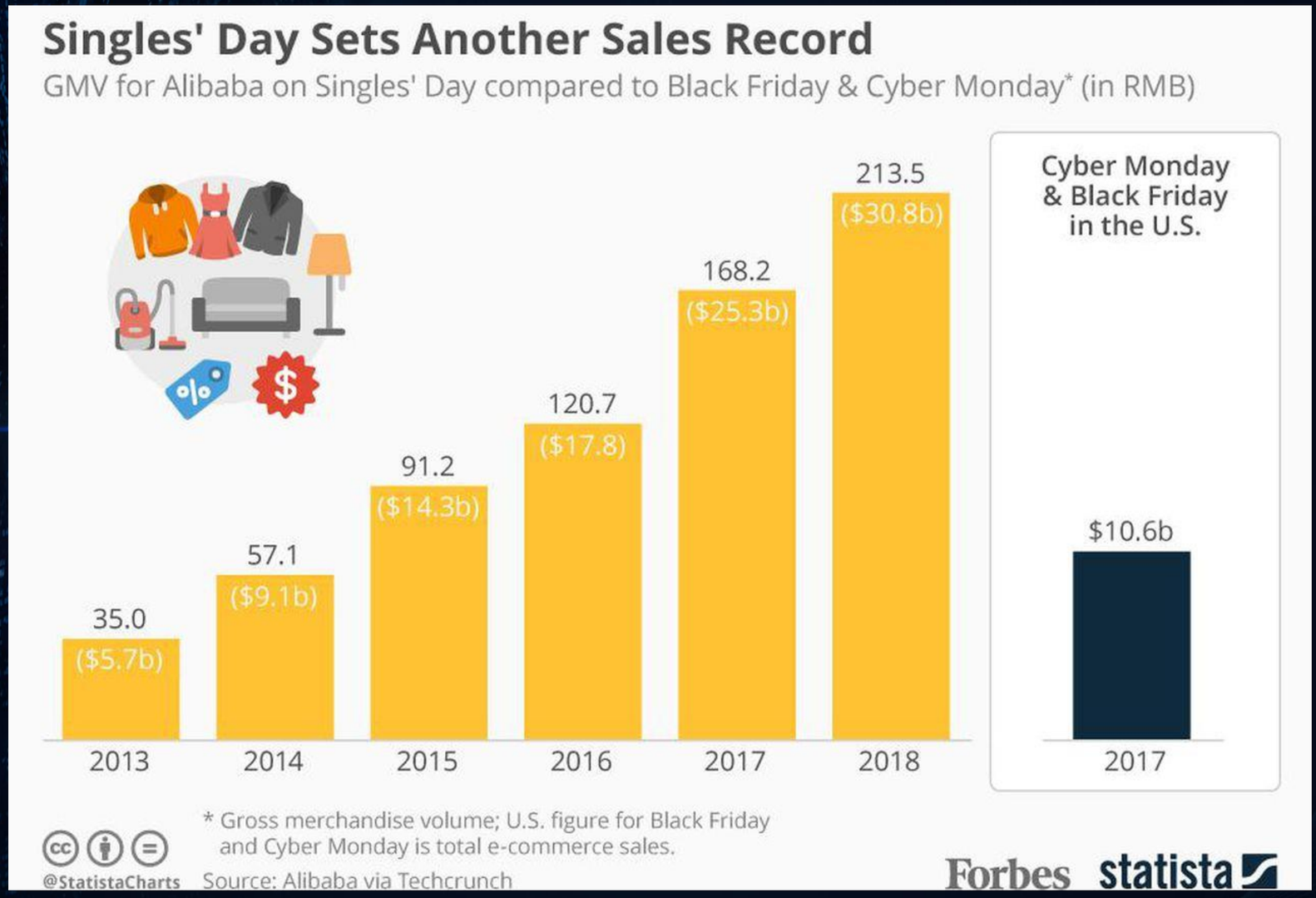
Chief Scientist, Amap (AutoNavi), Alibaba Group

Who is Alibaba

Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

Alibaba @ Hangzhou

Alibaba in E-commerce



Alibaba Eco-System

Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

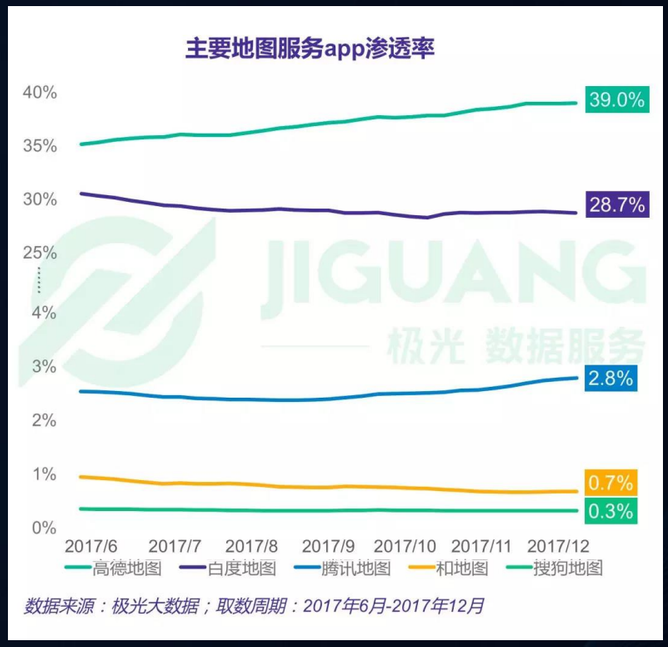
Who is **Amap** (AutoNavi)?

No.1 Mapping and Navigation Company in China

426M active users
(QuestMobile 2018/07)

8.2M km roads

70M POI



← **Amap**

Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

Who is **Amap** (AutoNavi)?

No.1 Map in China and No.1 Human-Location Relations

426M active users
(QuestMobile 2018/07)

8.2M km roads

70M POI

People & Activities

Locations & Places

Who is **Amap** (AutoNavi)?

No.1 Map in China and No.1 Human-Location Relations

426M active users

(QuestMobile 2018/07)

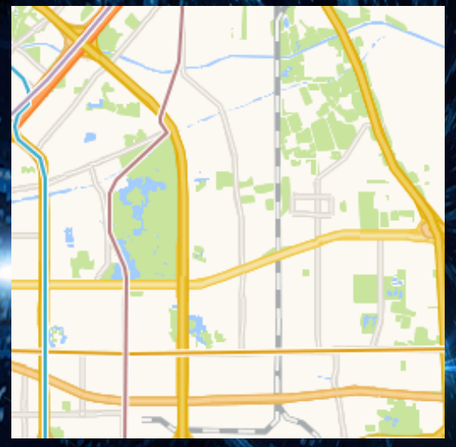
8.2M km roads

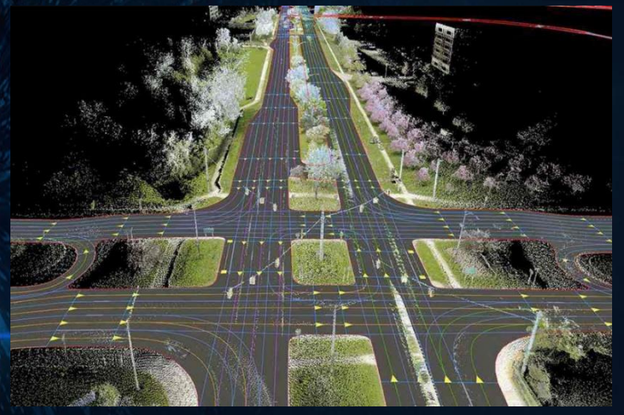
70M POI

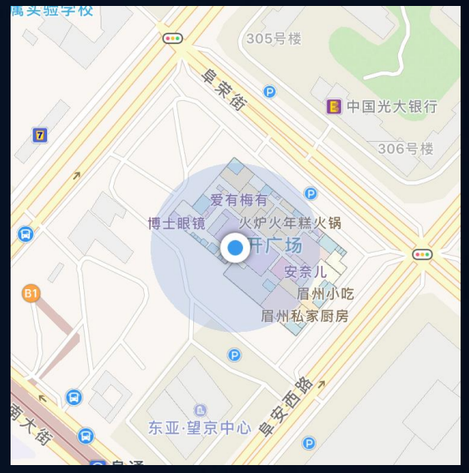
Upper Body

Lower Body

Computer Vision @ Amap







SD Map HD Map

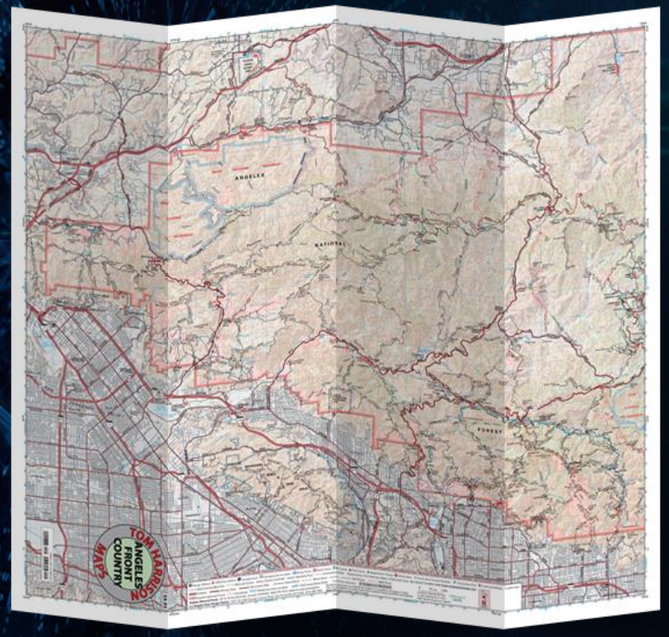
Mapping Automation

Location AR Navigation

“Easy” Navigation

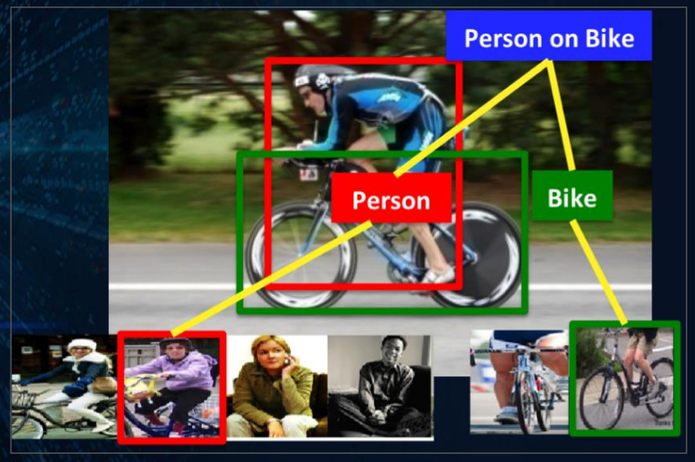
Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

Under the Hood



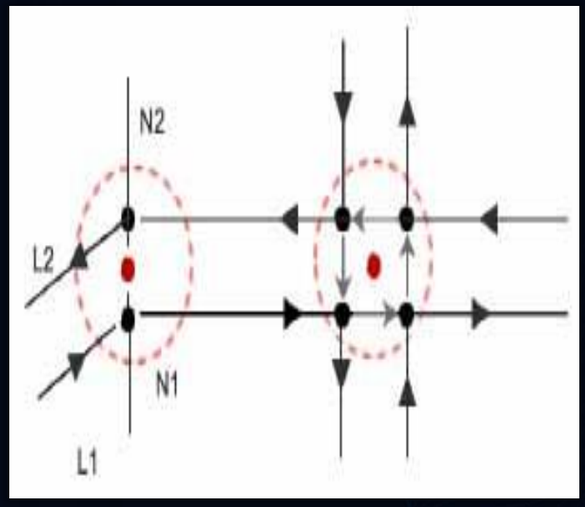
Basic Pipeline of Map Production

Data Acquisition



Automatic Recognition

Fusion & Human Editing



Map Database & Service

Auto-Generation of Road Data

Detection → Classification → Sign & Text Recognition

Auto-Generation of Road Data

a. “not allowed”

b. long-distance coach

c. 2:00-5:00

1. Detection & Classification

2. Parsing & Text Reading

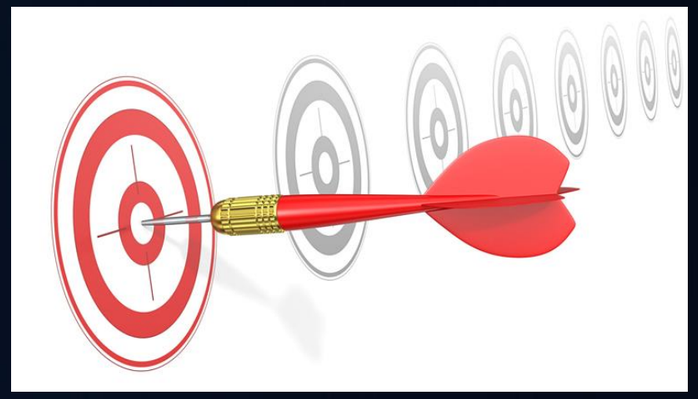
Why is Mapping (still) a Problem?

Map is a “deep” business

… and it’s hard in a hectic world

Mapping is a “Deep” Business

Scale (and diversity)



Accuracy (and updating)

Complexity (and specification)

Cost (and data quality)

Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

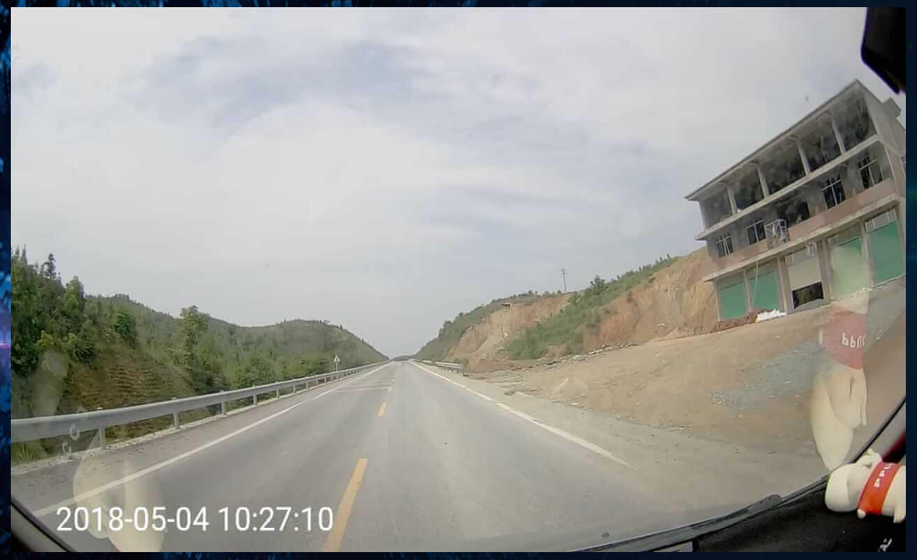
Challenge: Data Quality

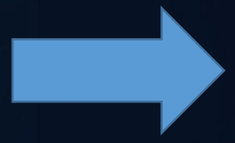
Challenge: Data Quality

Distortion
Reflection
Occlusion

Resolution
Compression
Image quality
… …

Auto Calibration in the Wild





Unknown camera: focal length, distortion, height and pose

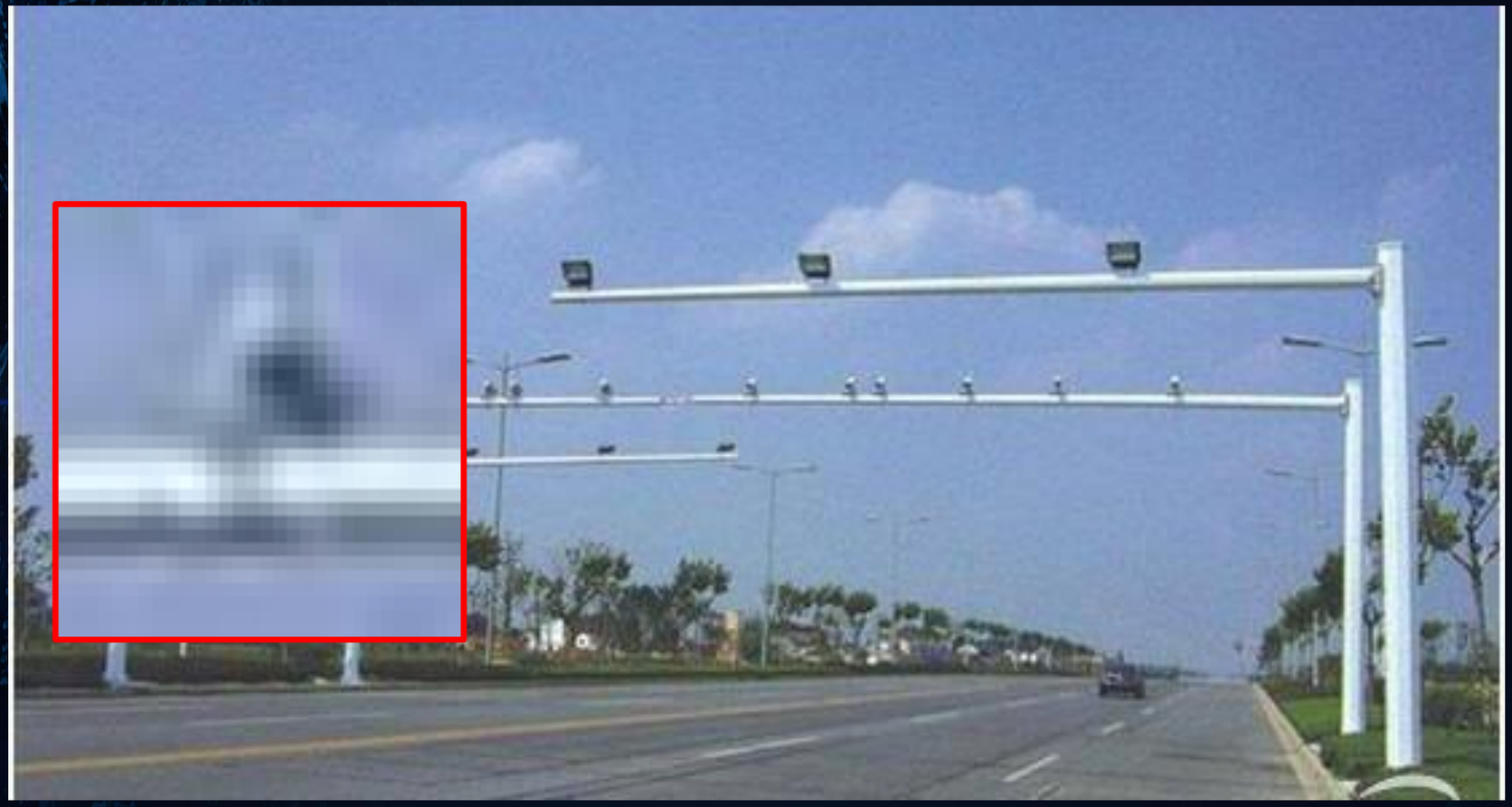
Solution: combine multiple data sources

Image Enhancement

Original

Challenge: Small Objects

Challenge: Small Objects

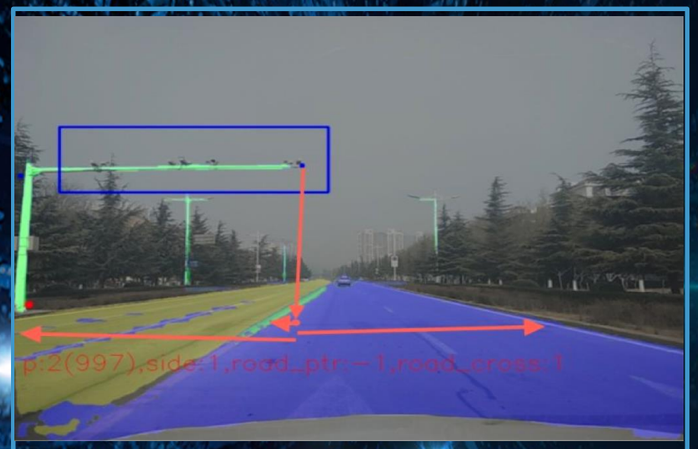


Challenge: Small Objects

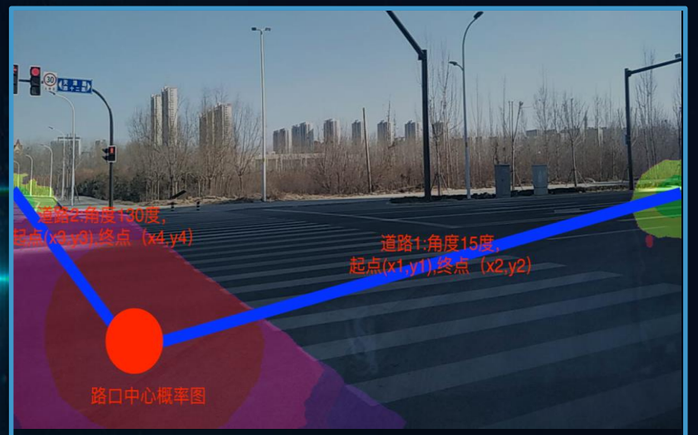
Challenge: Scene Complexity

Does this electronic eye belong to the current road? Which lane?

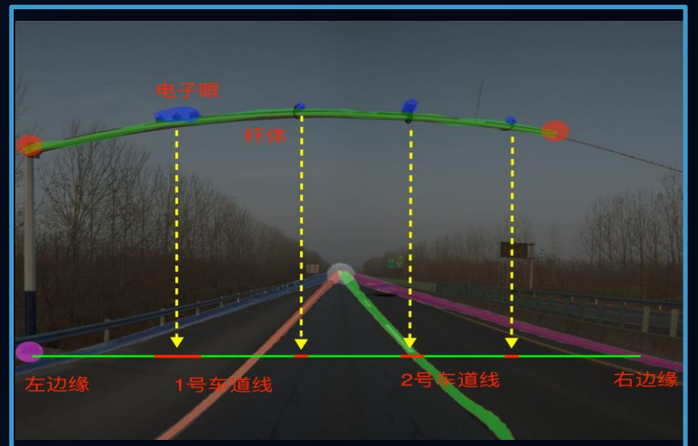
Challenge: Scene Complexity



Scene “geometry”



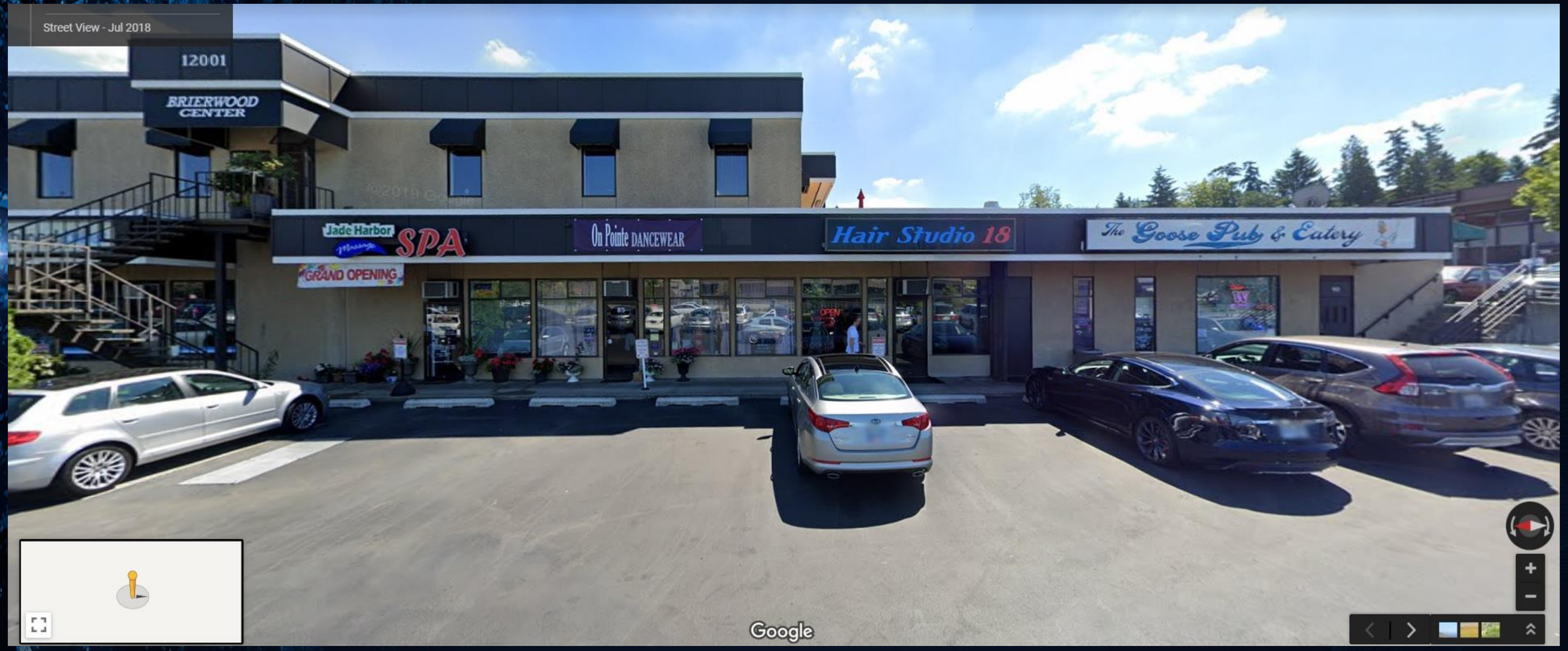
Junction analysis



Lane projection

- Object detection
- Semantic segmentation
- Scene understanding
- Geometry and calibration

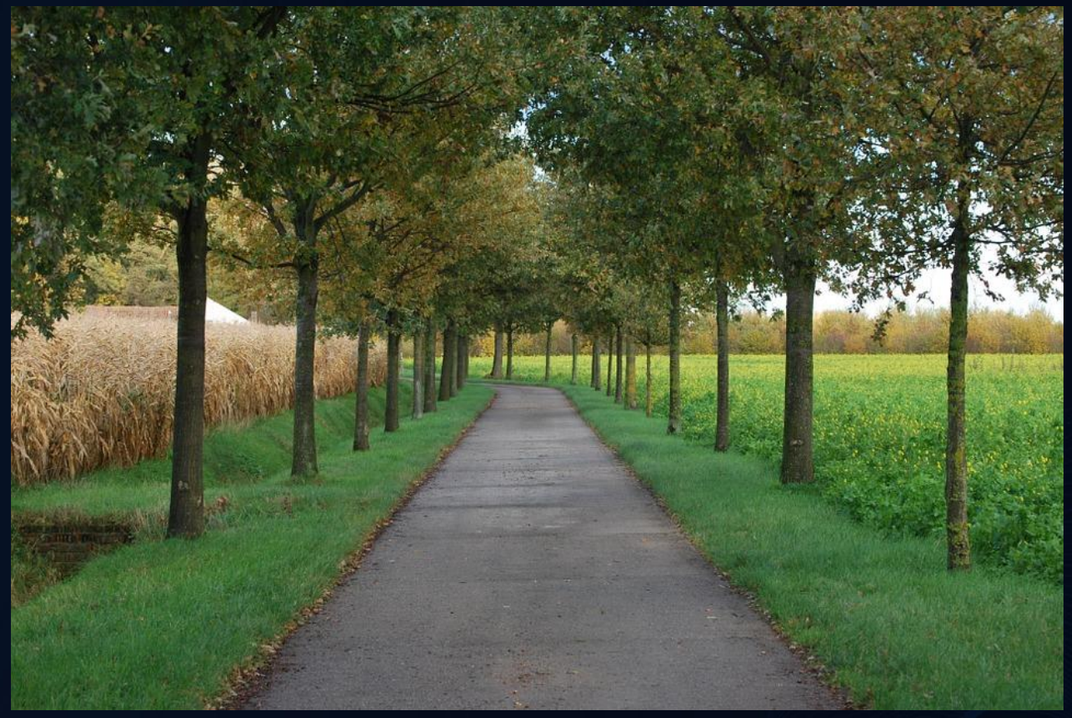
Challenge: Scene Complexity



Challenge: Scene Complexity

Challenge: Ambiguity

Challenge: Ambiguity



Challenge: Ambiguity

Challenge: Frequent Changes

Change Detection

- Object matching
  - Feature + deep learning
- Context matching
  - Segmentation + relations
- Scene matching
  - Feature + deep learning

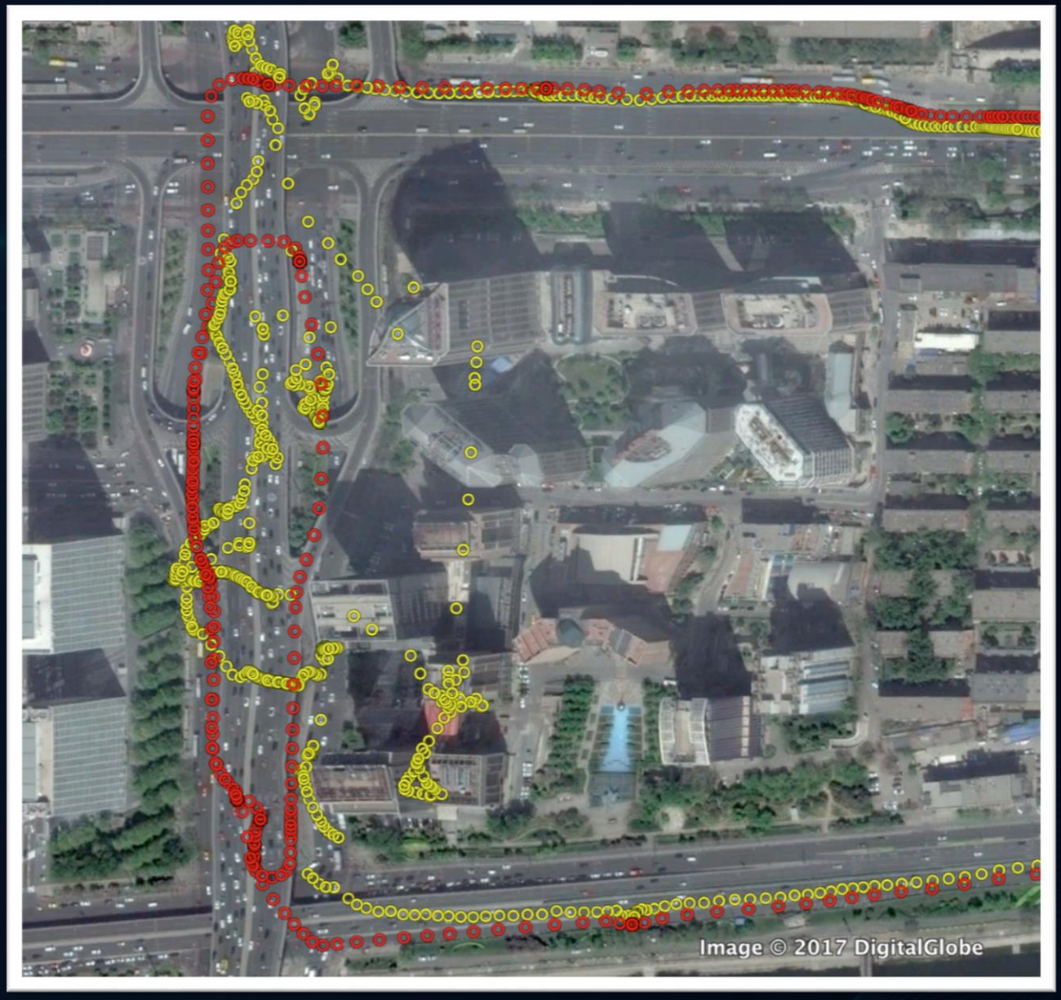
Challenge: Ambiguity

Can cars turn here?

Solution: Vision + GPS

Challenge: Location

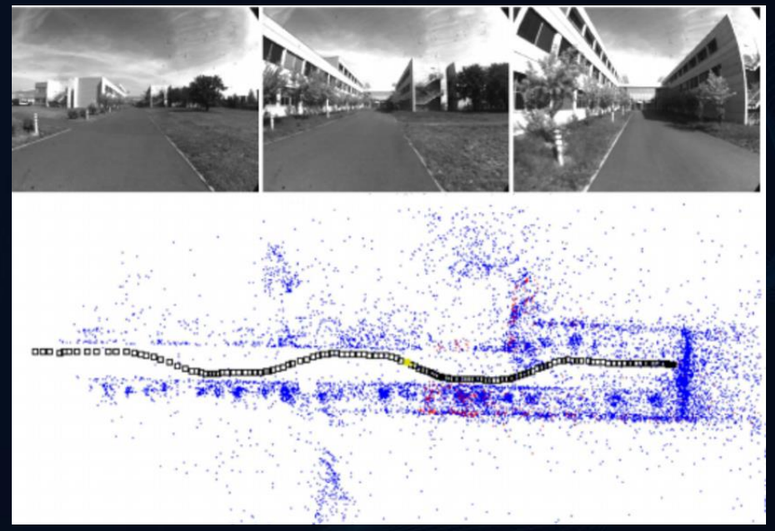
Urban Canyon



Challenge: Location

WiFi

Vision



How We Solve Problems in Practice

- Data quality, including annotation
- Data quantity, esp. failure cases
- Iterative improvements (and leaps)
- Combining algorithms from multiple angles
- Human-computer collaboration

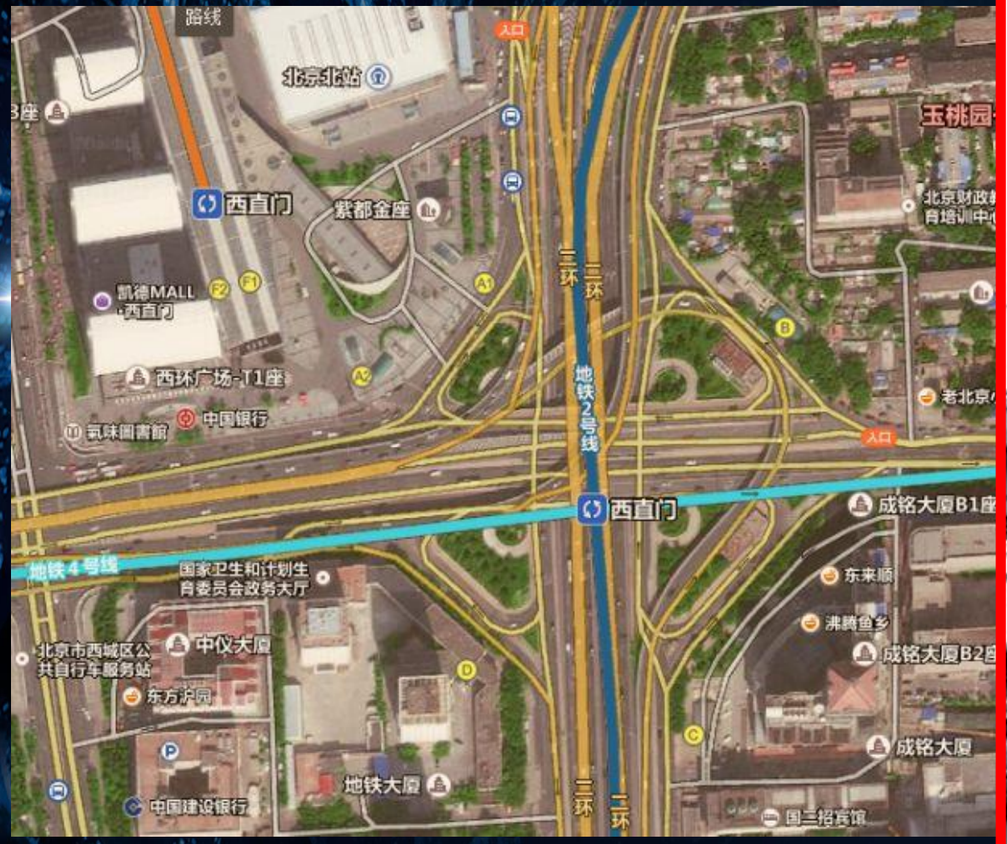
Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

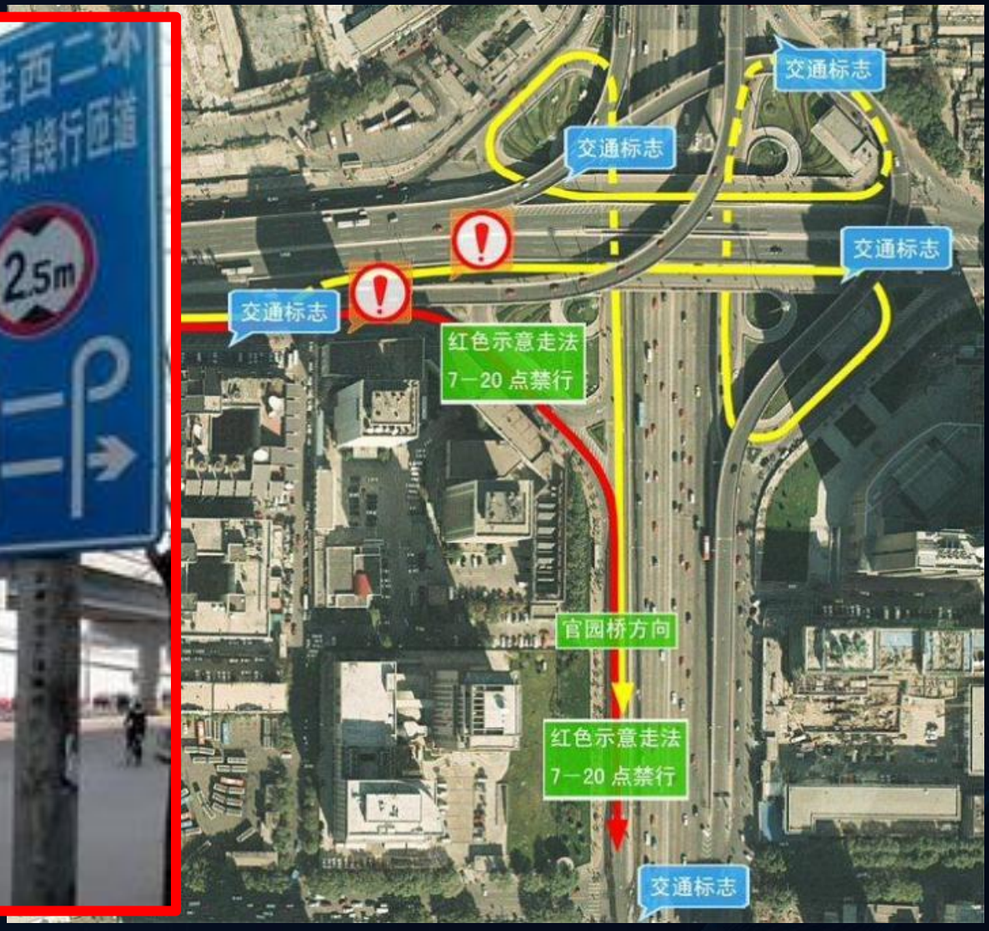
Still, Reality Can Beat You

Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

Still, Reality Can Beat You

Still, Reality Can Beat You

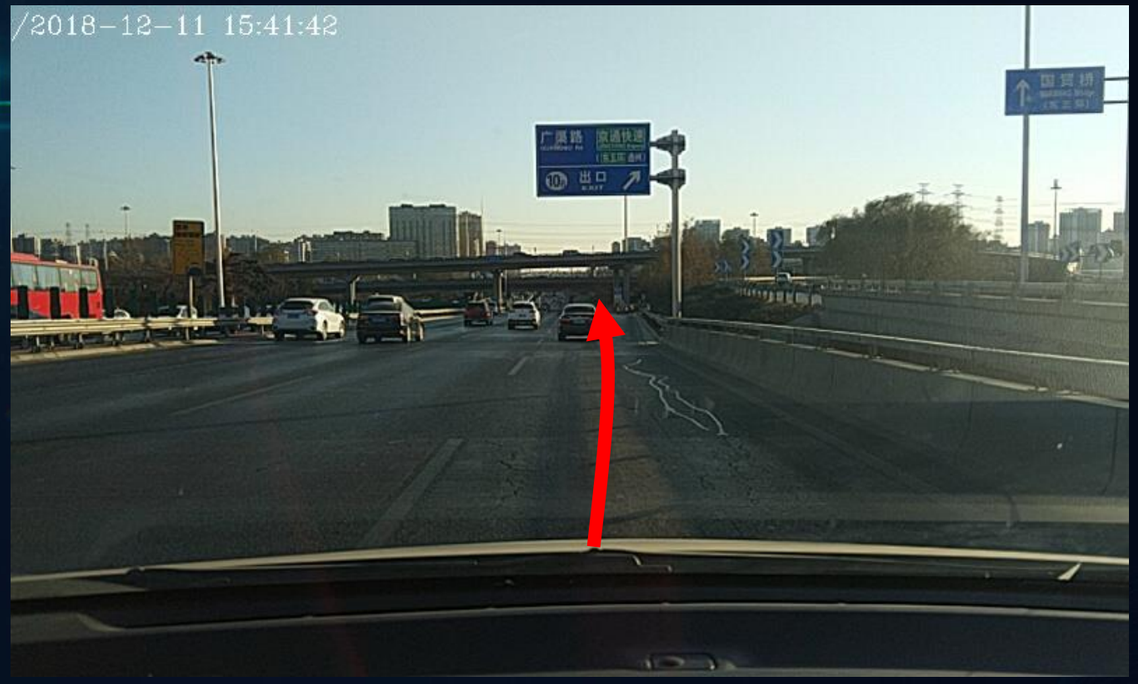




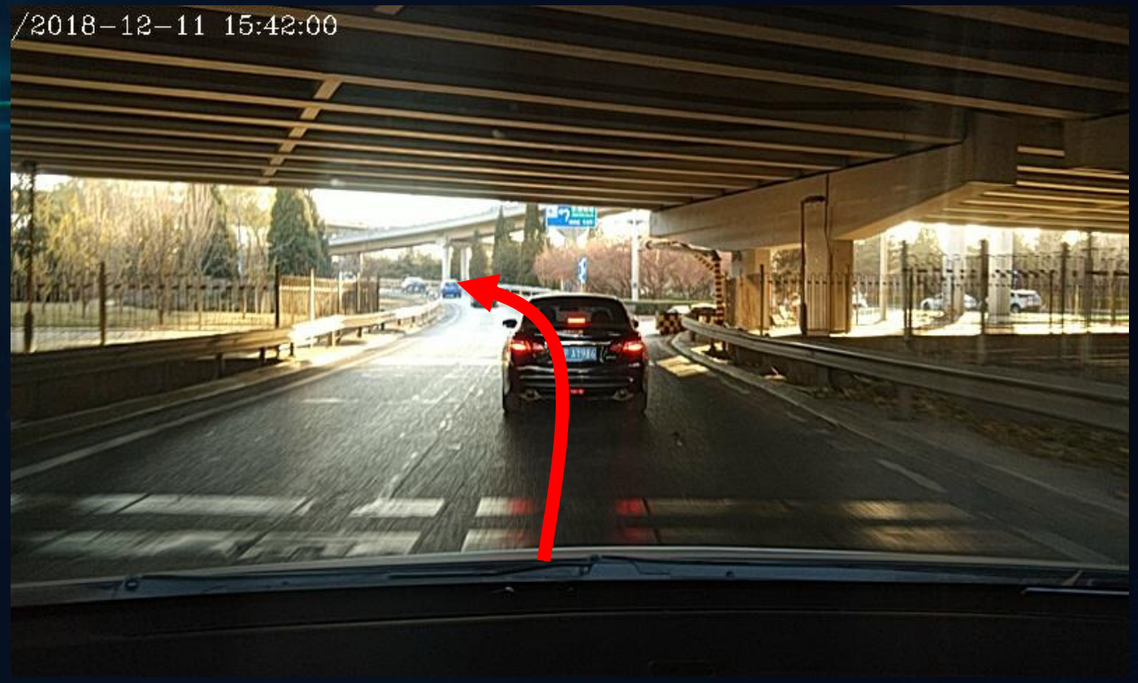
Next-Gen Navigation

- Accurate map
- Accurate location
- “Easy” directions

Abstract vs WYSIWYG



Abstract vs WYSIWYG

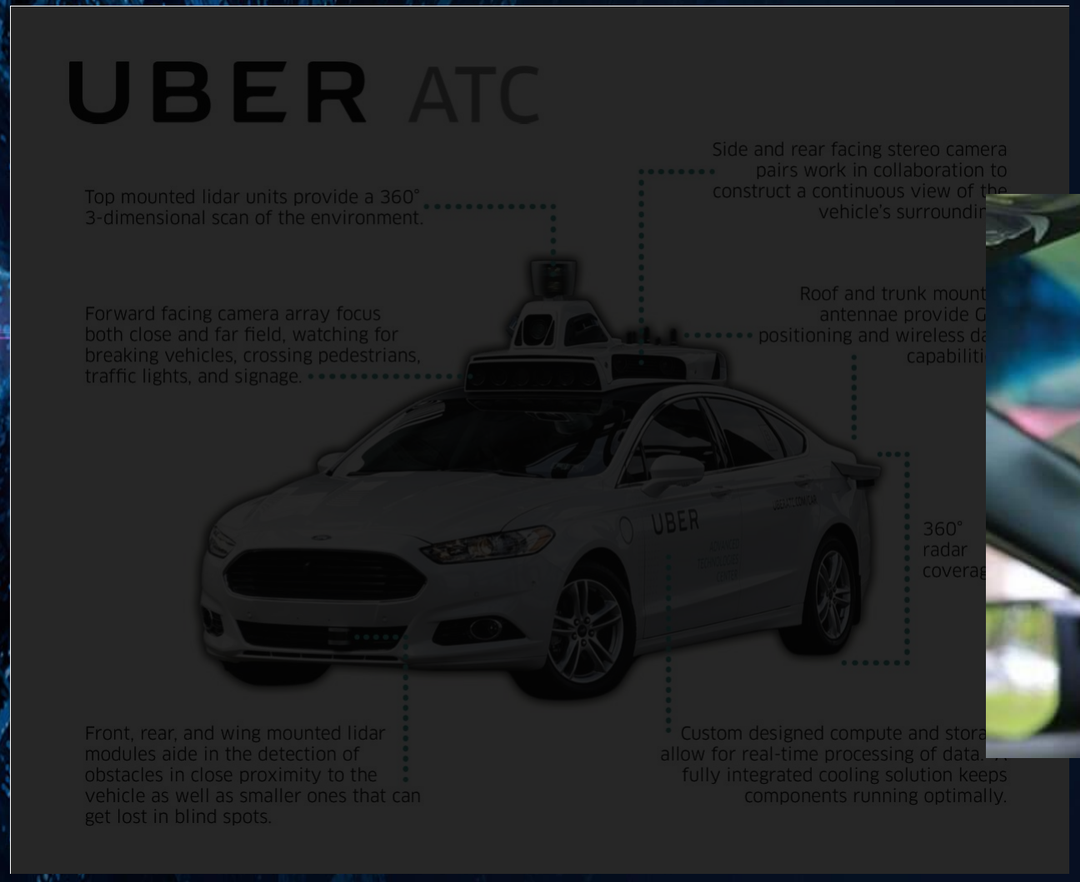


AR Navigation

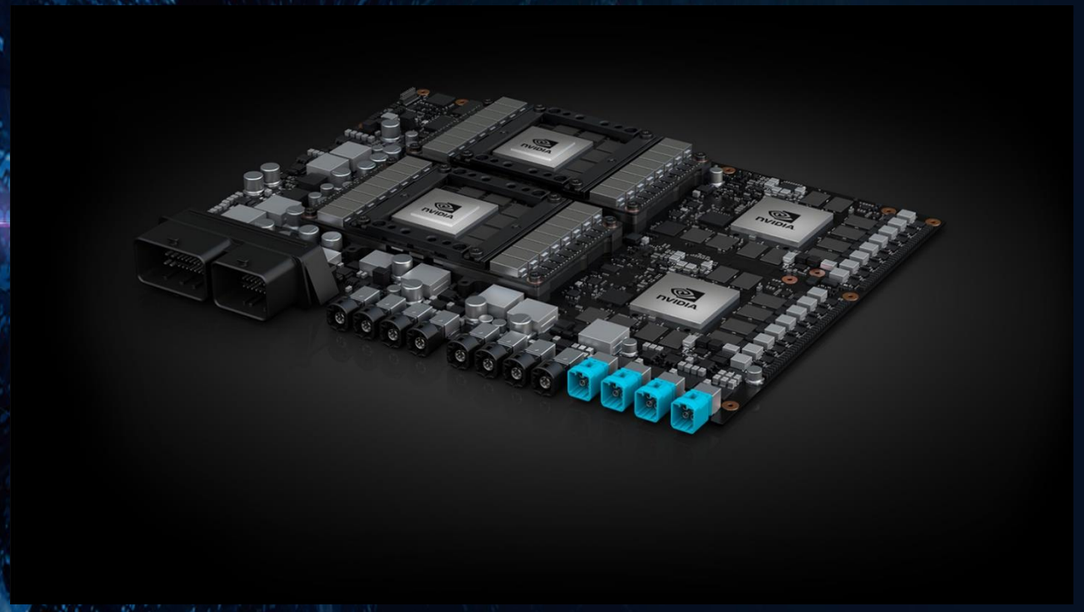
Launched April 2019

AR Navigation

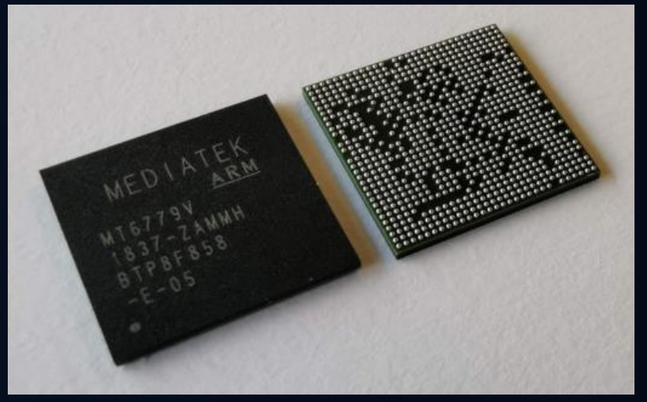
Challenge: Minimal Sensing



Challenge: Minimal Compute

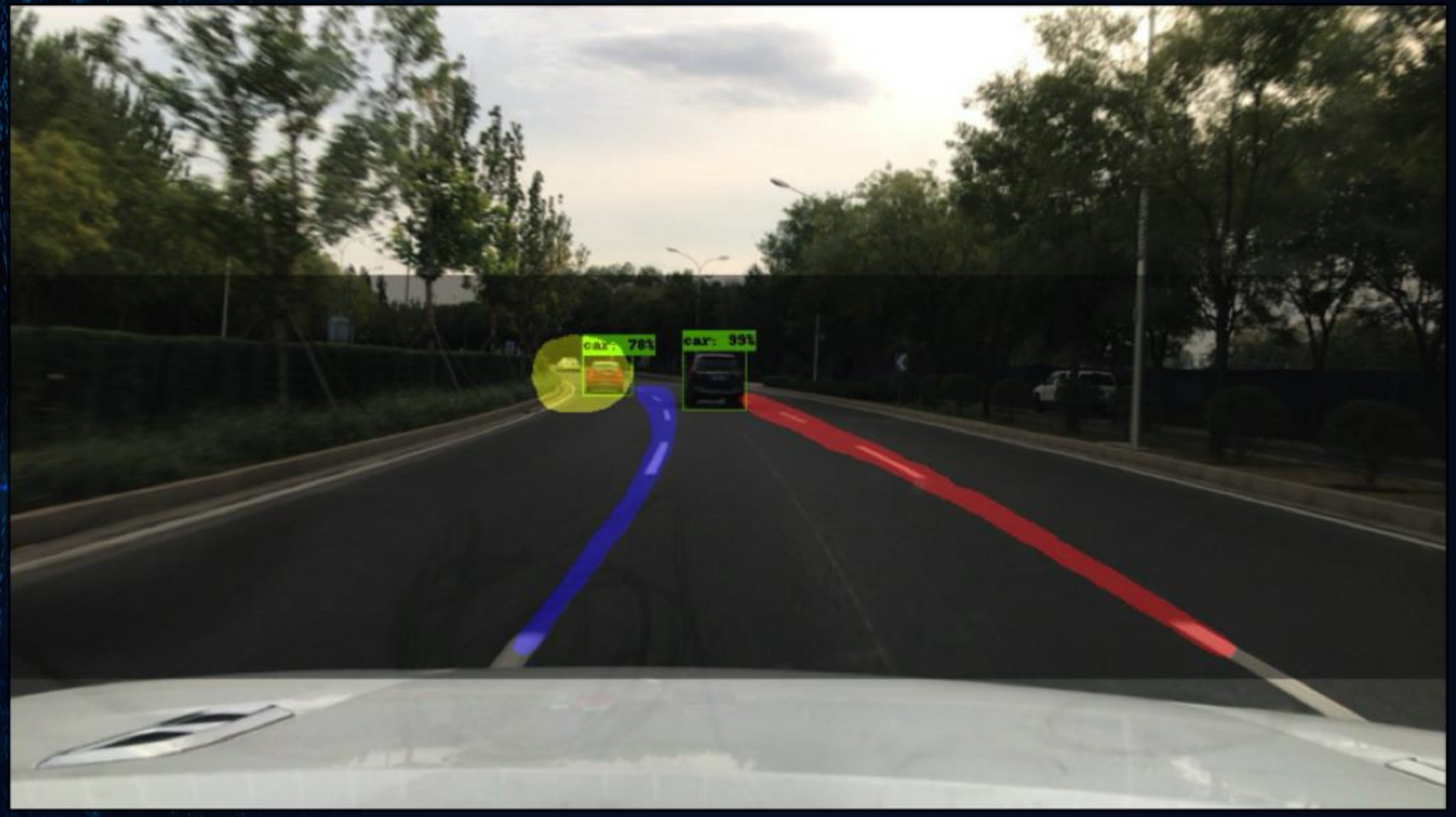


Nvidia DRIVE AGX



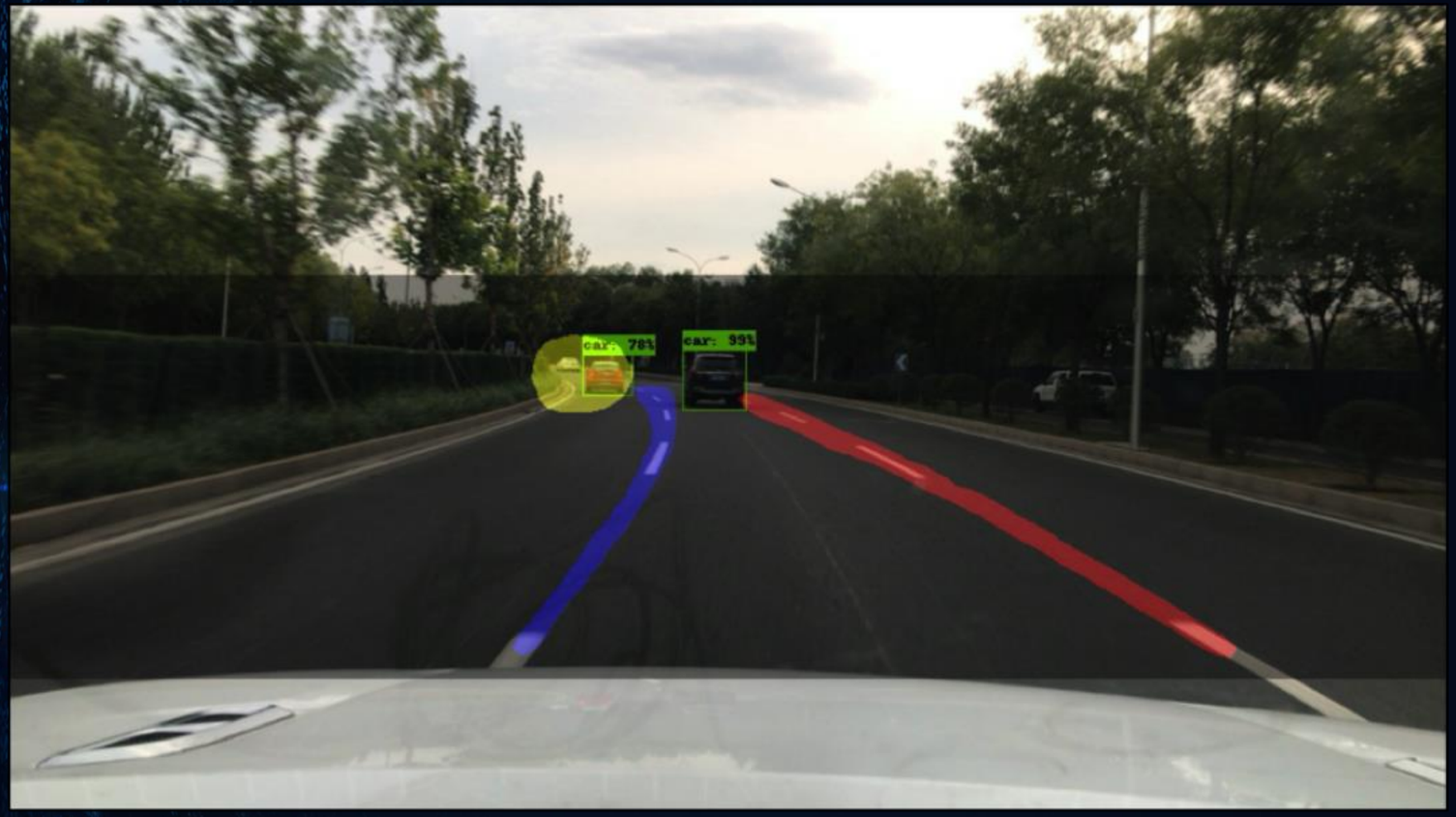
MTK8783

AR Navigation: Car Detection



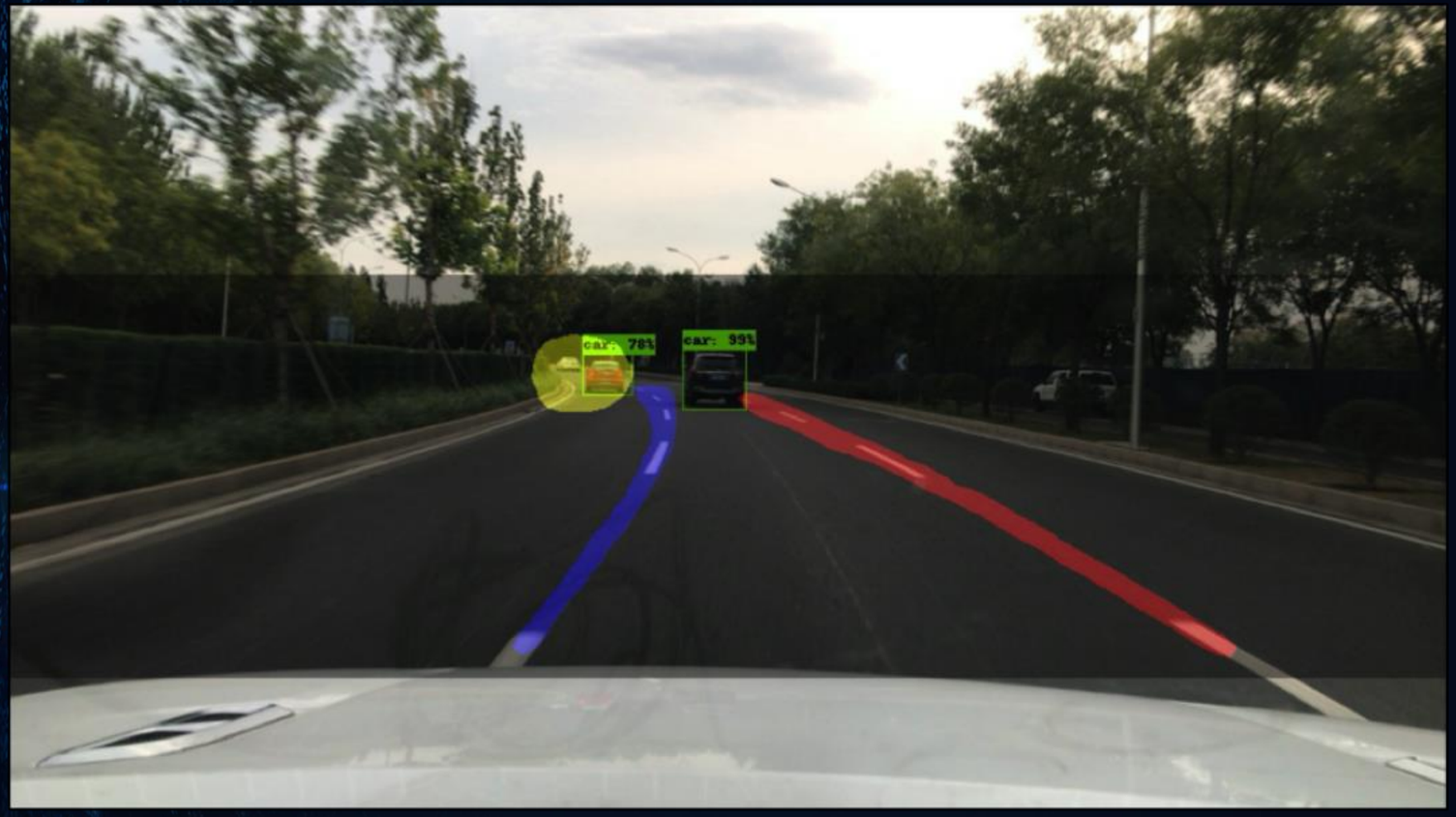
(1) model compression (2) utilize scale (3) combine with tracking

AR Navigation: Lane Boundary Detection



(1) multi-task (2) curve fitting (3) weighting and loss

AR Navigation: Direction and Location



(1) multi-task (2) use segmentation for prediction

(3) use regression to predict lane number (4) combine with GPS

AR Navigation: Compute

1/5 of typical smartphone

(1) Multi-tasking model

(2) Model compression

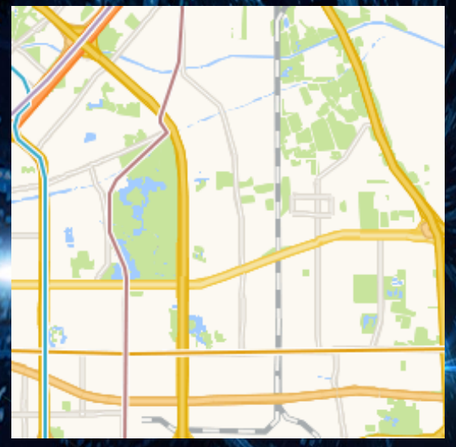
(3) Optimize implementation

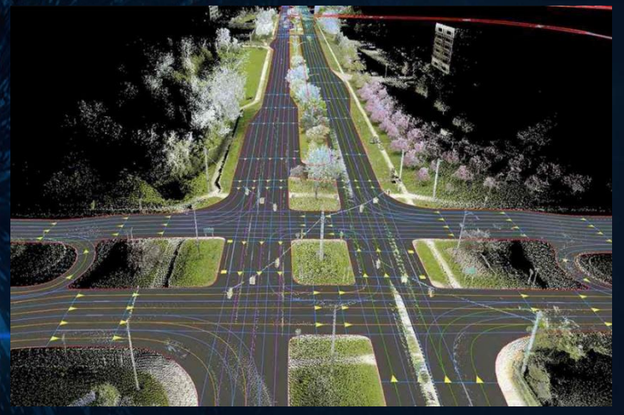
(4) Balance GPU/CPU (and transfer)

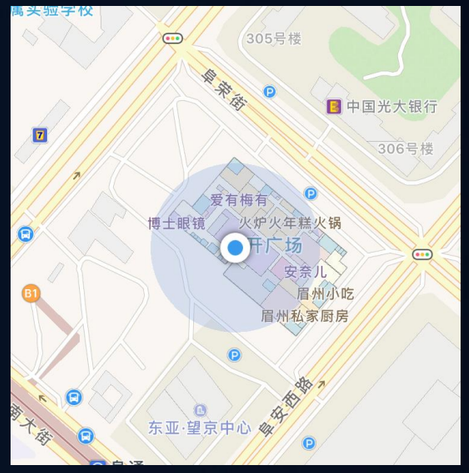
(5) Reduce context switching

(6) … and the rest of the system

Computer Vision @ Amap







SD Map HD Map

Mapping Automation

Location AR Navigation

“Easy” Navigation

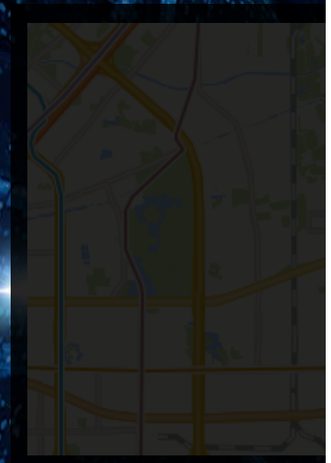
Computer Vision @ Amap

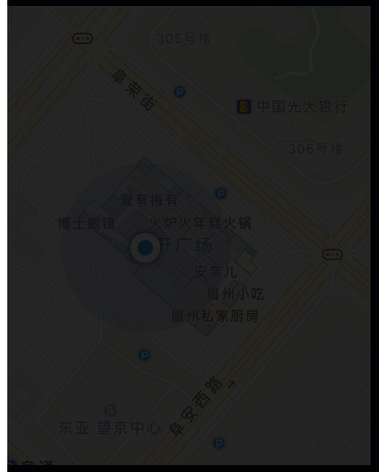
Alibaba's AutoNavi commercializes HD map by charging automakers license fee

By Robert Fri Apr 12 2019

Alibaba-backed online mapping service AutoNavi is commercializing its mapping service by charging the company's automobile partners for using its high-definition (HD) map, which is a critical piece in self-driving solutions, local financial news outlet *Lanjinger* reported.

AutoNavi is charging automakers RMB 100 (USD 15) per car per year for licensing the HD map, which captures the world with centimeter-precision whereas ordinary web map apps represents the world at a meter-level accuracy.





SD M

Location

AR Navigation

Map

"Easy" Navigation

Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

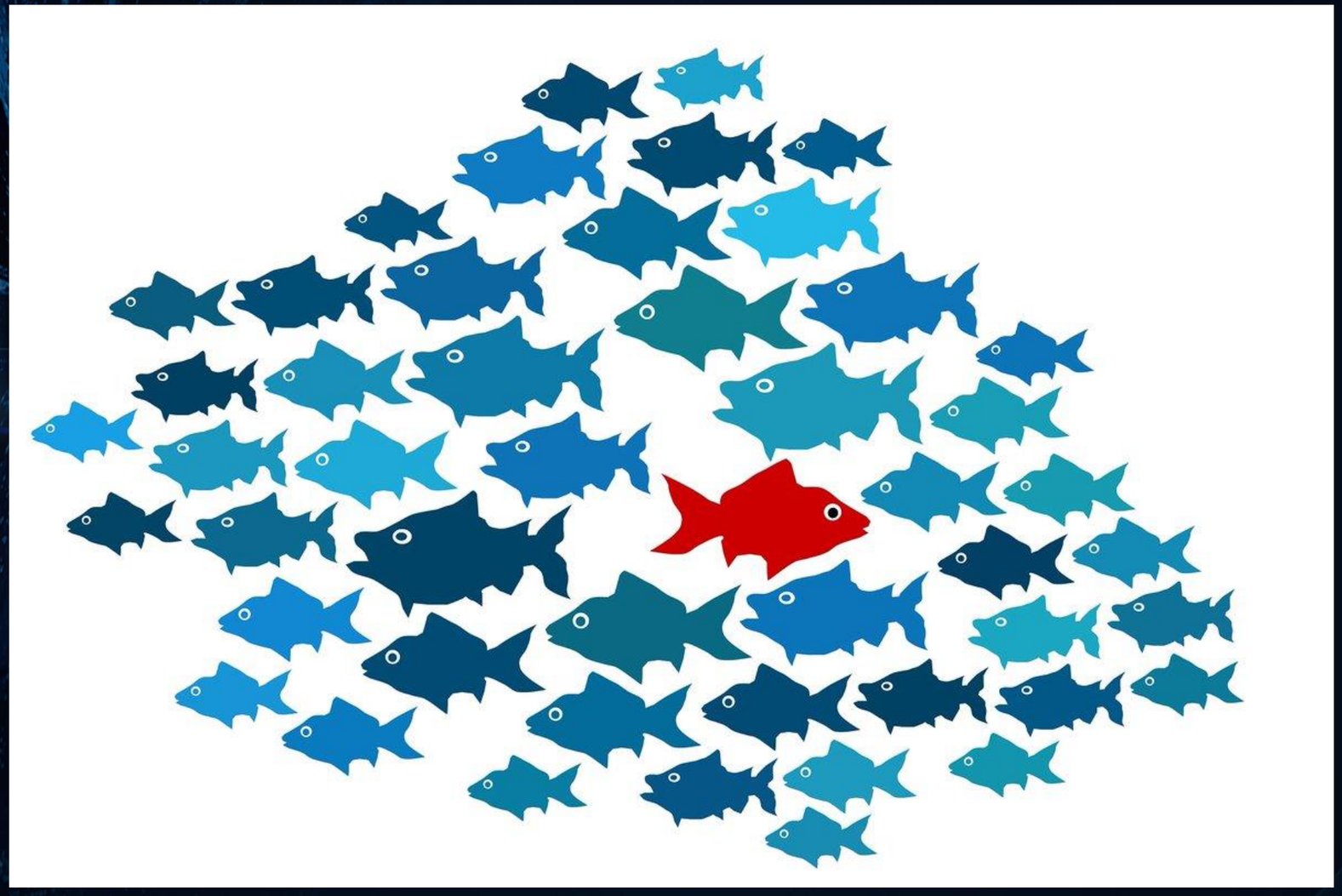
The Future of Mapping and Navigation

People driving cars

Machine driving cars

Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

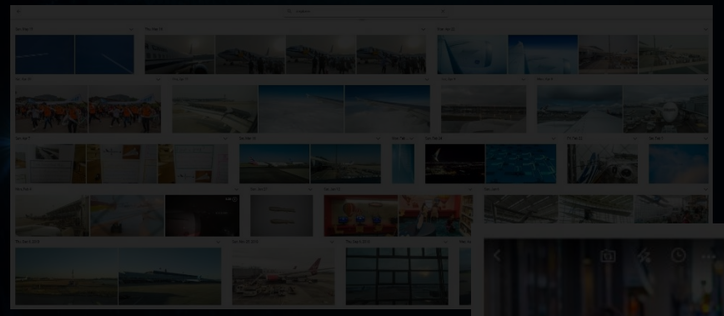
The Future of Mapping and Navigation

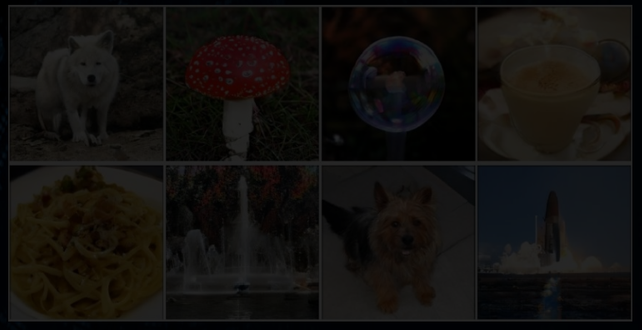


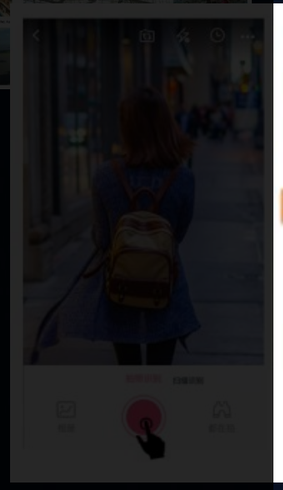
Alibaba Group 阿里巴巴集团 | 高德地图 amap.com

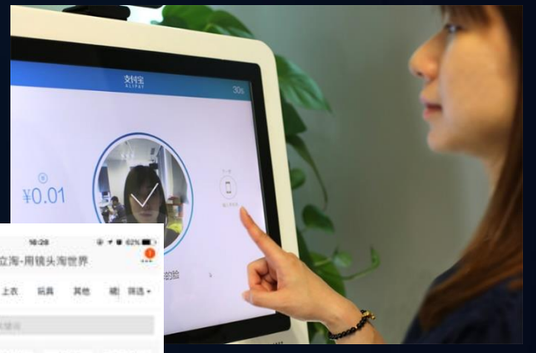
Computer Vision Applications

Cloud | Real World



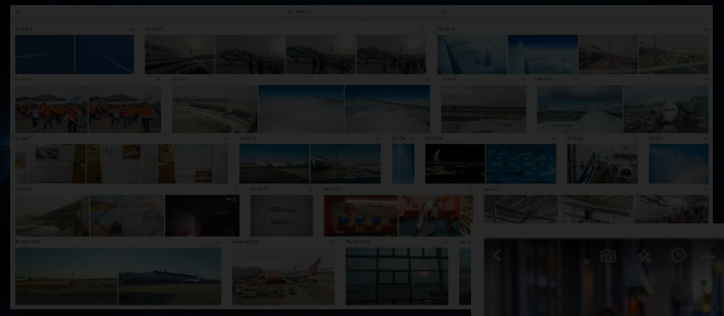


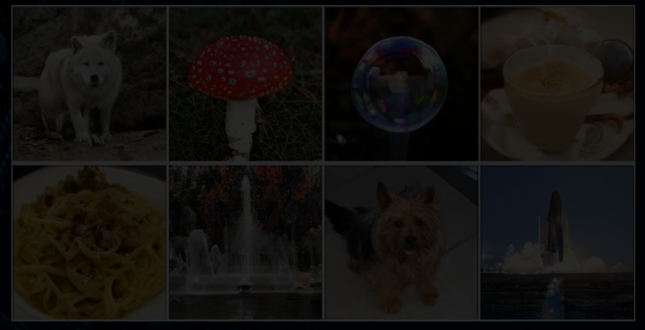


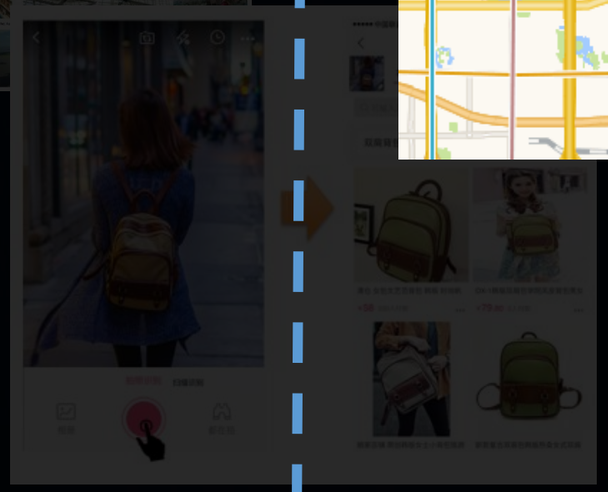


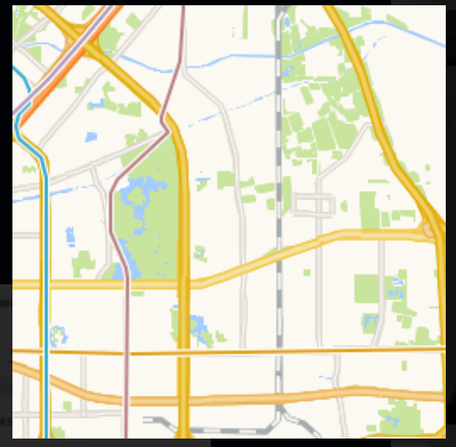
Computer Vision Applications

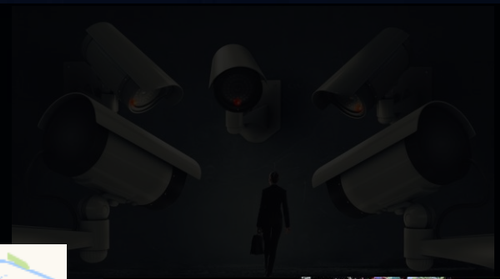
Cloud | Real World

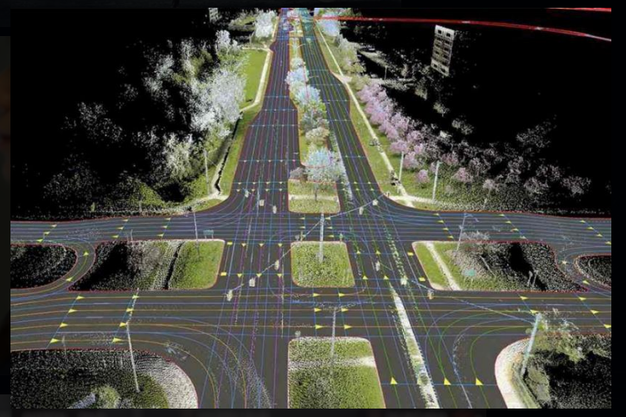












Thank You