

Science of Algorithmic Map Inference

MIT & QCRI

Why Map Inference ?

The billion dollar war over maps

by Seth Fiegerman @sfiegerman

During a test drive near Ford's Michigan headquarters, the team noticed something strange with its self-driving cars.

Each car shifted slightly at the same point in the lane "as if they were avoiding a pothole," says Jim McBride, Ford's senior technical leader for autonomous cars.

The problem wasn't the cars -- it was the map.

The team had just updated its 3D map of the test route, which helps guide self-driving cars. But a minor glitch caused one pixel on the map to have the wrong data value. It told the car a spot in the ground was raised 10 inches, when it was perfectly level.

"The new map looked perfect to the human eye," McBride says. But not to the eye of a self-driving car. "A single incorrect pixel," he says, was enough to throw off the cars.

The power of that tiny mapping glitch, which happened a few years ago, highlights the newfound importance of a product many consumers likely take for granted.

Uber is planning on investing \$500 million to map the world's roads

This will reduce Uber's reliance on Google Maps

by [Andrew Liptak](#) | [@AndrewLiptak](#) | Jul 31, 2016, 5:54pm EDT

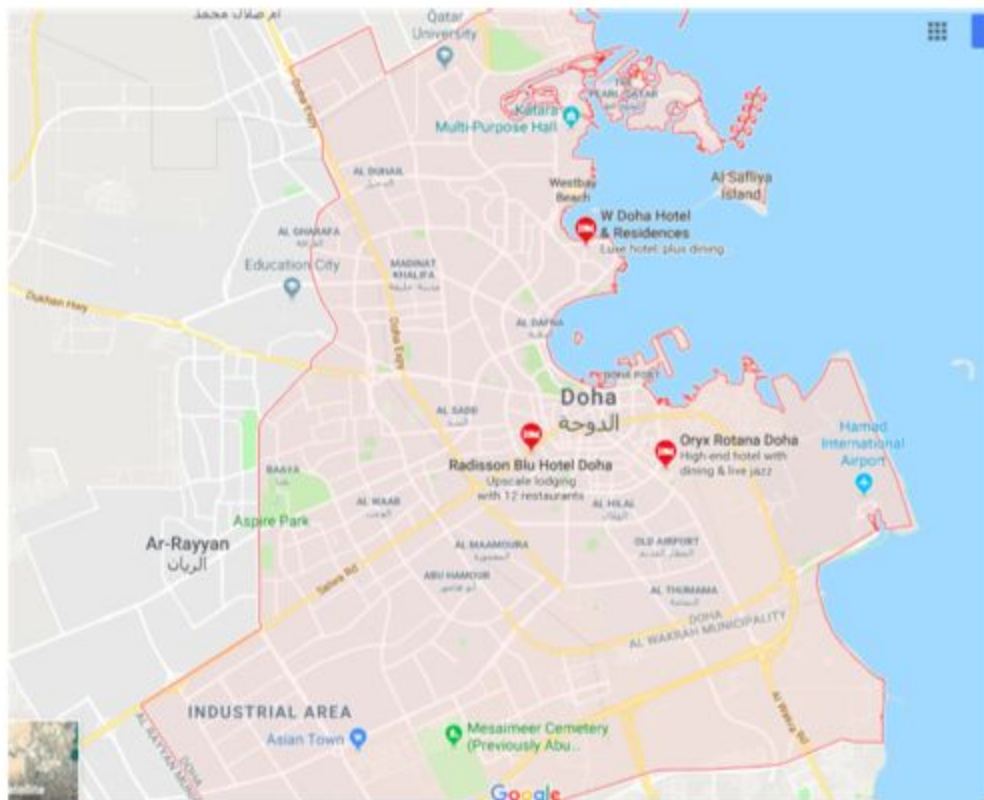
Will Your Next New Car Help Build Maps for Self-Driving?

Mobileye will use cameras on a growing list of automakers' cars to build maps for self-driving vehicles.

Why Ford Motor Is Investing in 3D Mapping Startup Civil Maps

Tencent, partners invest in HERE's digital maps to get a leg up on self-driving cars

Today: tedious process with some manual curation steps



Map Construction Problem

Given:

- Given a geographic region R and a road network N_R within R
- A collection of GPS trajectories $\{G\}$ with footprint within R
- A collection of satellite images $\{S\}$ which cover R

Task: Infer a directed graph N_{infer} from $\{G\}$ and $\{S\}$

Objective: N_{infer} is a geometric and topological subgraph of N_R

Map Update Problem

Given:

- Given a geographic region R
- Two graphs G_1 and G_2 which represent the road network in R

Task:

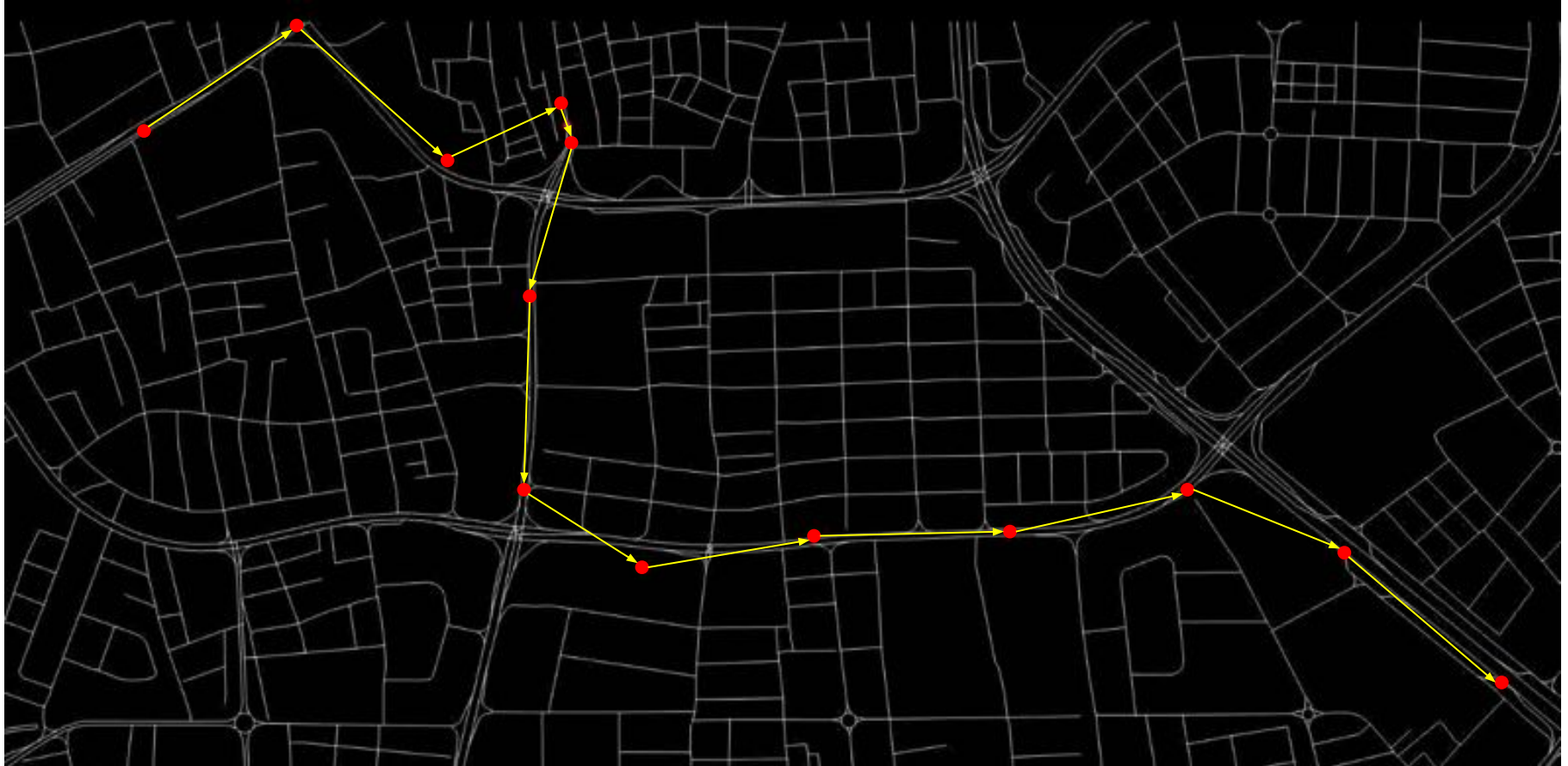
Fuse (or merge) the graphs in a “seamless” fashion

Example: G_1 is a base map and G_2 is a map inferred from GPS traces

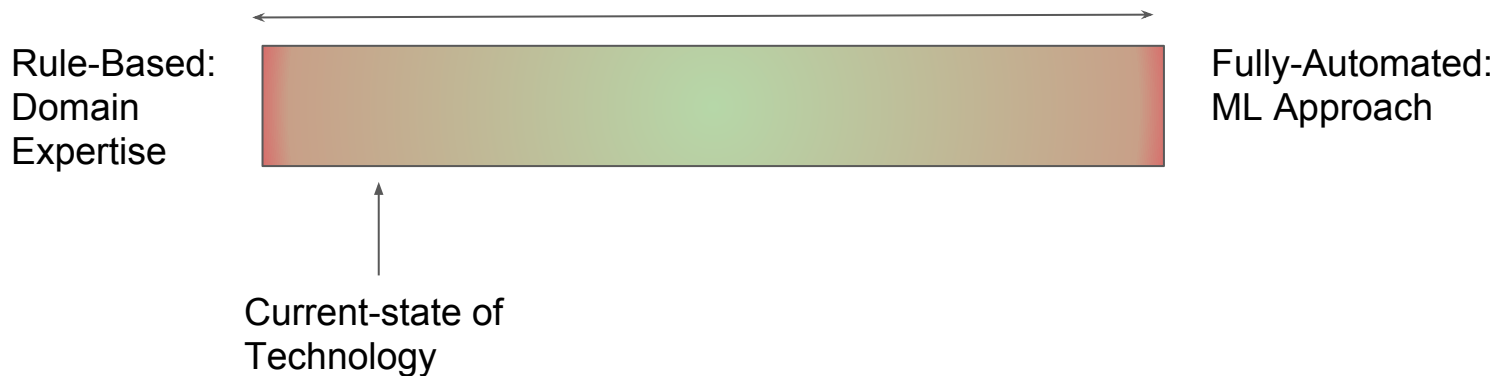
Why is the Problem Hard ?

- Data Scientists work with “secondary data”
 - Primary data is too expensive (i.e., data collected with the purpose for map construction)
- GPS data:
 - Inherently noisy; urban canyons (~10/20 meters)
 - Sampling rate varies (e.g., data point every 300 meters)
 - Lat/Long more accurate than height (overpass/underpass problem)
- Satellite Data:
 - Timing mismatch with GPS data
 - Plus all the “problems” with satellite data (e.g. Cloud obfuscation)

A single GPS Trace



Current Map Construction Technology Spectrum



Google vs. Waze



Google

Waze

