Google Self-Driving Car Project
Monthly Report

January 2016

Activity Summary (all metrics are as of January 31, 2016)

Vehicles

- 22 Lexus RX450h SUVs – currently self-driving on public streets; 15 in Mountain View, CA, 7 in Austin, TX
- 33 prototypes – currently self-driving on public streets; 26 in Mountain View, CA & 7 in Austin, TX

Miles driven since start of project in 2009

"Autonomous mode" means the software is driving the vehicle, and test drivers are not touching the manual controls. "Manual mode" means the test drivers are driving the car.

- Autonomous mode: 1,419,672 miles
- Manual mode: 988,925 miles
- We're currently averaging 10,000-15,000 autonomous miles per week on public streets

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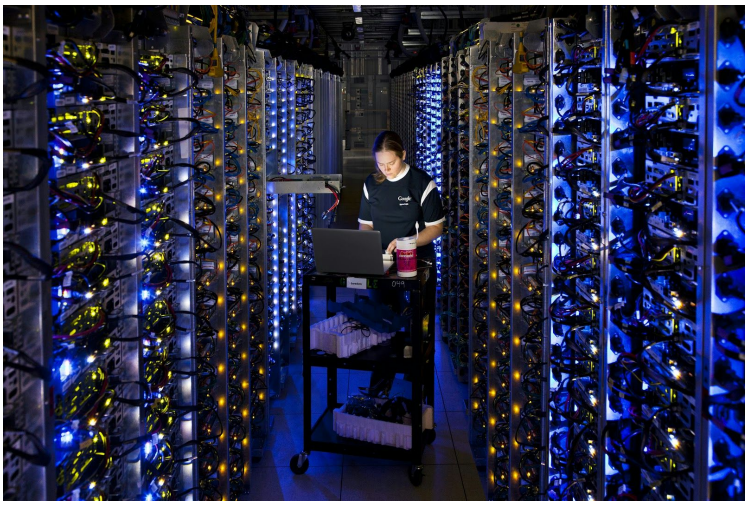
Reliving the past: how these data centers drive us three million miles each day.



Testing on public roads is a vital part of developing our software, allowing us to drive in new environments and come across new experiences. But with the powerful driving simulator that we've developed we're also able to learn without a single car leaving the garage.

Our engineers are regularly adding new capabilities and refining the car's driving by making improvements to the software. Before we roll out any change to our fleet of cars, we first test it extensively in this virtual environment.

One benefit of teaching a computer to drive is that it has great memory and recall. With our simulator, we're able to call upon the millions of miles we've already driven and drive those miles again with the updated software. For example, to make left turns at an intersection more comfortable for our passengers, we modified our software to adjust the angle at which our cars would travel. To test this change, we then rerun our entire driving history of 2+ million miles with the new turning pattern to ensure that it doesn't just make our car better at left turns, but that the changes creates a better driving experience overall.

We can also create entirely new scenarios in our simulator, allowing us to concentrate on perfecting a particular skill. For example, to test our car's performance in a three car merge, we will create thousands of variations of this situation (each car travelling at different speeds, and nudging to merge at different times) and then test that our car drives as intended each time.

Our simulator can also help our test drivers and engineers quickly identify any areas for improvement. Each time a test driver takes over from the self-driving car, we're able to play back the exact situation and predict via simulation what could have happened if the car had been left to drive itself. If the simulator shows better driving is called for, our engineers can make refinements to the software, and run those changes in simulation in order to test the fixes.

All together, we drive more than 3 million miles in simulation every day. That's the equivalent of circling the equator five times, every hour. All of this simulated driving requires huge computing power and luckily we're able to call upon Google's data centers for help!

Getting the green light in Austin

Like most city streets, there's lots of traffic lights in our hometown of Mountain View, CA. However, these lights are typically vertically aligned. Last year, when we were deciding on Austin, TX as the next location for our testing program, we noticed that most of the traffic lights were horizontal.

Before our cars drive autonomously in a new location, we first manually drive the area to create a map that allows the car to know what to expect from a street environment -- lane lines, how high traffic signals are from the ground, curb heights, bridges. In Austin, one of other tasks was to collect more traffic light data and add it to the database of millions of other examples of traffic lights we've seen before. Being able to closely examine each element of driving also allows us to see minute differences (e.g. traffic lights in Austin are dimmer than in Mountain View) and calibrate our sensors accordingly to help us clearly see traffic lights wherever we drive.

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Traffic Accidents Reported to CA DMV

None for the month of January.

What we've been reading

- **Backchannel:** "License to (Not) Drive", (January 2016)
- **Mother Jones:** "No Parking Here", (January 2016)
- **New York Times:** "Self-Driving Cars May Get Here Before We're Ready", (January 2016)
- **Wall Street Journal:** "Japan Road Tests Self-Driving Cars to Keep Aging Motorists Mobile", (January 2016)
- **Fortune:** "Feds Try to Hit the Gas on Self-Driving Cars", (January 2016)
- **Washington Post:** "These charts show who's lapping whom in the race to perfect the driverless car", (January 2016)