

Open-Sourcing Self-Driving Cars



Outline

- I. Brief History of Autonomous Cars
- II. Open Source, DIY, Udacity
- III. DEMO: Udacity / Behaviour Cloning

I. Brief History of Self-driving Cars

1920s, 50s, 90s ...

2005 DARPA Grand Challenge – 132 Miles of Fully Autonomous Desert Driving

Winner: robot Stanley by Stanford Team

http://www.cs.stanford.edu/people/dstavens/thesis/David_Stavens_PhD_Dissertation.pdf

2007 DARPA Urban Challenge – 60 Miles of ‘Urban’ Driving

Winner: CMU/GM team.

Second Place: robot Junior by Stanford Team

<http://robots.stanford.edu/papers/junior08.pdf>

2009 Google X

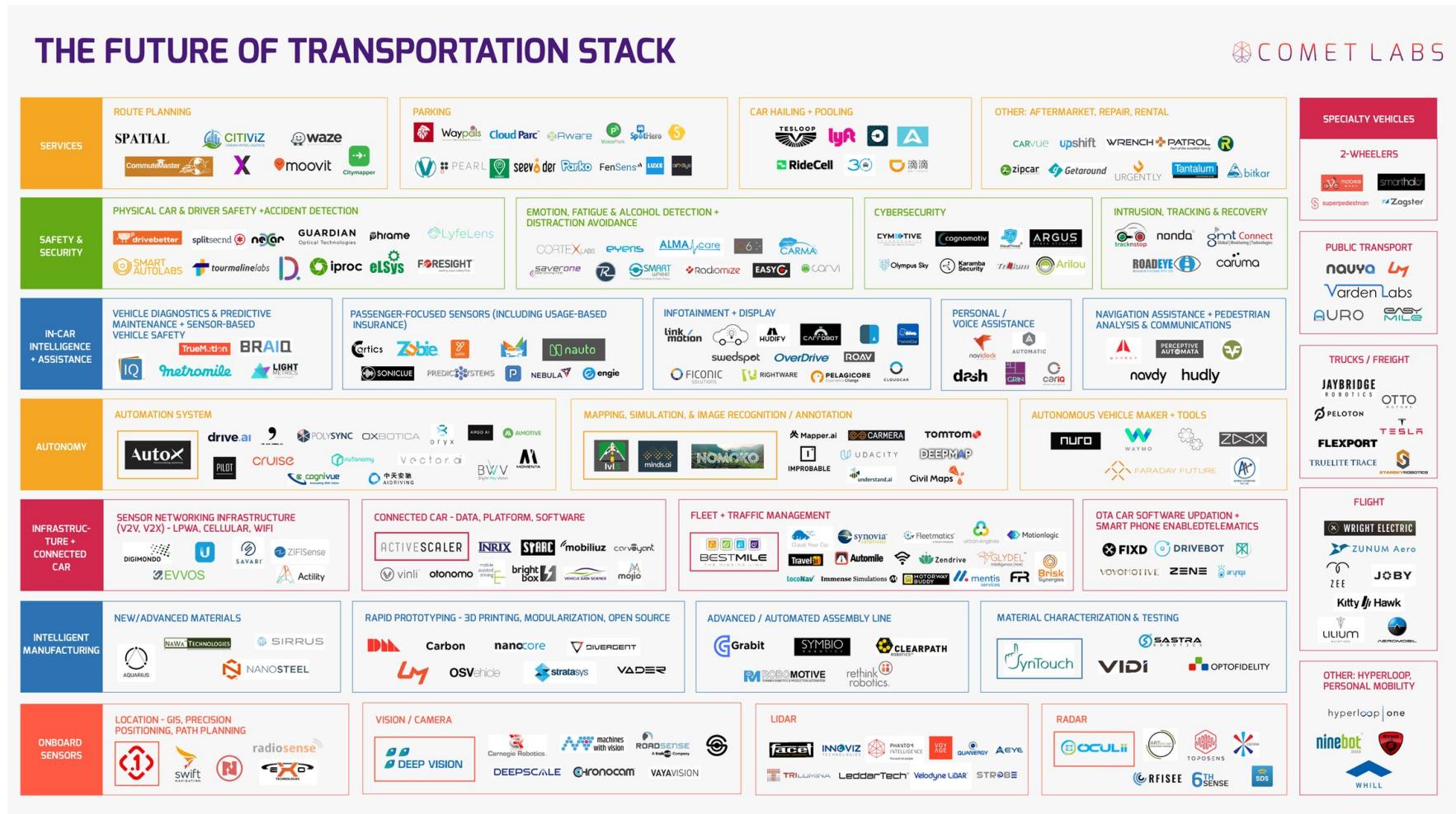
Mostly Stanford team develops the first prototypes of Google autonomous cars

~2014 Everyone: big car manufacturers, rides-haring companies, OEM suppliers etc start working on mass-market SDC technology

2017: most companies promise Level 5 autonomy by 2020

I. Brief History of SDC: 2017

Comet Labs: 263 Companies Racing Towards Autonomous Cars



I. Brief History of SDC: Main Catalysts

Why now?

Main catalysts:

- Advances in car technology
 - ✓ Electric powertrain
 - ✓ Drive-by-wire controls
 - ✓ Advanced driver assistance systems
 - ✓ Cheaper and better sensors: cameras, RADARs, LIDARs
- Connectivity/Cloud/Big Data
 - ✓ detailed 3D maps
 - ✓ traffic, driving patterns data
 - ✓ other crowd-sourced data
- AI / Machine Learning / Computer Vision
 - ✓ Better compute capabilities at ‘The Edge’ – GPUs, ASICs etc
 - ✓ State of the art results in image recognition/classification
 - ✓ State of the art results in reinforcement learning

II. Open Source: It is all about SOFTWARE

Logical Next Step: Open-Source [self-driving cars]

We know this in PyData community ☺

Seriously?

Well, it turns out it is [almost] all about software.

Autonomous car is a ROBOT, which does the following, in a loop:

1. **Perceive** the world through sensors (HARDWARE)
2. **Make sense of the world** and plan an action (SOFTWARE – 90%)
3. **Execute** the action (HARDWARE)

April 2017:

<https://www.technologyreview.com/s/604220/baidu-will-release-a-free-operating-system-for-self-driving-cars/>

I told you! We'd better be quick, after all we use Python and they are probably on C++!

II. Open Source: Hacking, DIY

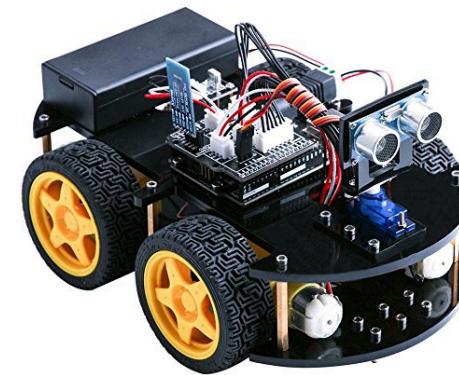
So, how do I hack a self-driving car?

Choose hardware platform:

Simulator / ROS



toy



medium-size (1/10)

Trooper Pro Edition 4x4 1/10 Brushless SCT (ARR)

QTY: - 1 +

£154.95

Add to cart

Wish List

Rating: ★★★★★

Stock: In Stock

Weight: 3282g

SKU: 9249001309-0

Read description

Report Issue Not Cheapest?

full-size (streetdrone.co.uk)



II. Open Source: More Hardware Ideas

More hardware ideas:

Drive-by-wire Kits For Full Size Vehicles (available to public)

- <http://oscc.io/> - 1000\$ Kia Soul 2014+, <https://github.com/PolySync/OSCC>
- <http://www.autonomoustuff.com/wp-content/uploads/2016/08/ADAS-Development-Vehicle-Kit.pdf> - Lincoln MKZ or Ford Fusion

DIY Toy Car Kits:

- <https://mit-racecar.github.io/hardware/> - based on <https://traxxas.com> plus NVIDIA Jetson plus cameras, laser range sensors, IMU and ECU for wheel odometry
- <https://diyrobocars.com/raspberry-arduino-car/> -- and many other designs
- https://docs.google.com/spreadsheets/d/1iaOru6va1LXjhXfBtYTWhAH_3DQlvVldpRZ0NJh-7q8/edit?usp=sharing -- possible configuration

II. Open Source: Data and Programming

- Open-Source Software
 - Tensorflow and other Deep Learning frameworks
 - OpenCV for computer vision
 - ROS – Robotics Operating System
 - Trained models for object detection, image segmentation, visual SLAM
 - ...
- Open Data Sets
 - <http://synthia-dataset.net/>
 - <http://www.cvlibs.net/datasets/kitti/>
 - <http://ori.ox.ac.uk/the-oxford-robotcar-dataset/>
 - ...

II. Open Source: Meetups and Projects

Meetups:

- <https://www.meetup.com/DIYRobocars> -- California
- <https://www.meetup.com/London-Self-Driving-Autonomous-Car-Technology-Meetup/>

Open Source Projects:

- <https://github.com/OSSDC> -- Open Source Self Driving Car Initiative
- <http://comma.ai/>

III. Udacity Nanodegree

Udacity started a (paid) nano-degree in October 2016

Self-Driving Car Engineer:

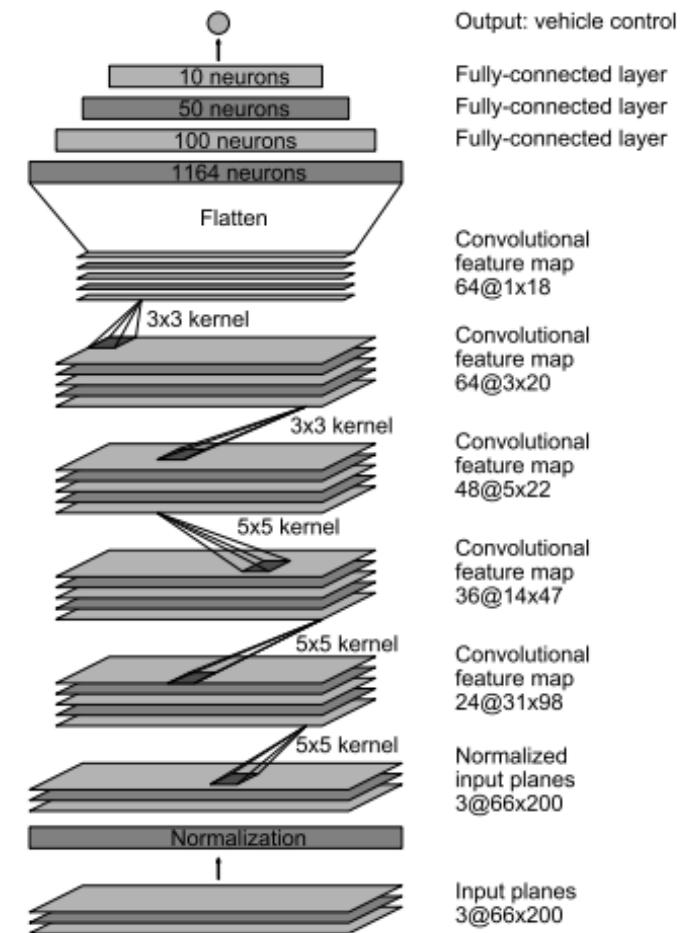
- Term 1
 - 1. Deep Learning
 - 2. Computer Vision
- Term 2
 - 1. Sensor Fusion
 - 2. Localization
 - 3. Control
- Term 3 (under development)
 - 1. Path Planning
 - 2. Elective (Advanced Deep Learning or Functional Safety)
 - 3. Team Project / Write a Component for Udacity Self-Driving Car

III. DEMO: Behavioural Cloning

Project from Term 1 at Udacity SDCEND

Use Deep Learning to drive car in a simulator

Python, tensorflow, keras



<https://github.com/asimonov/PyData-London-SDC-Behavioural-Cloning>

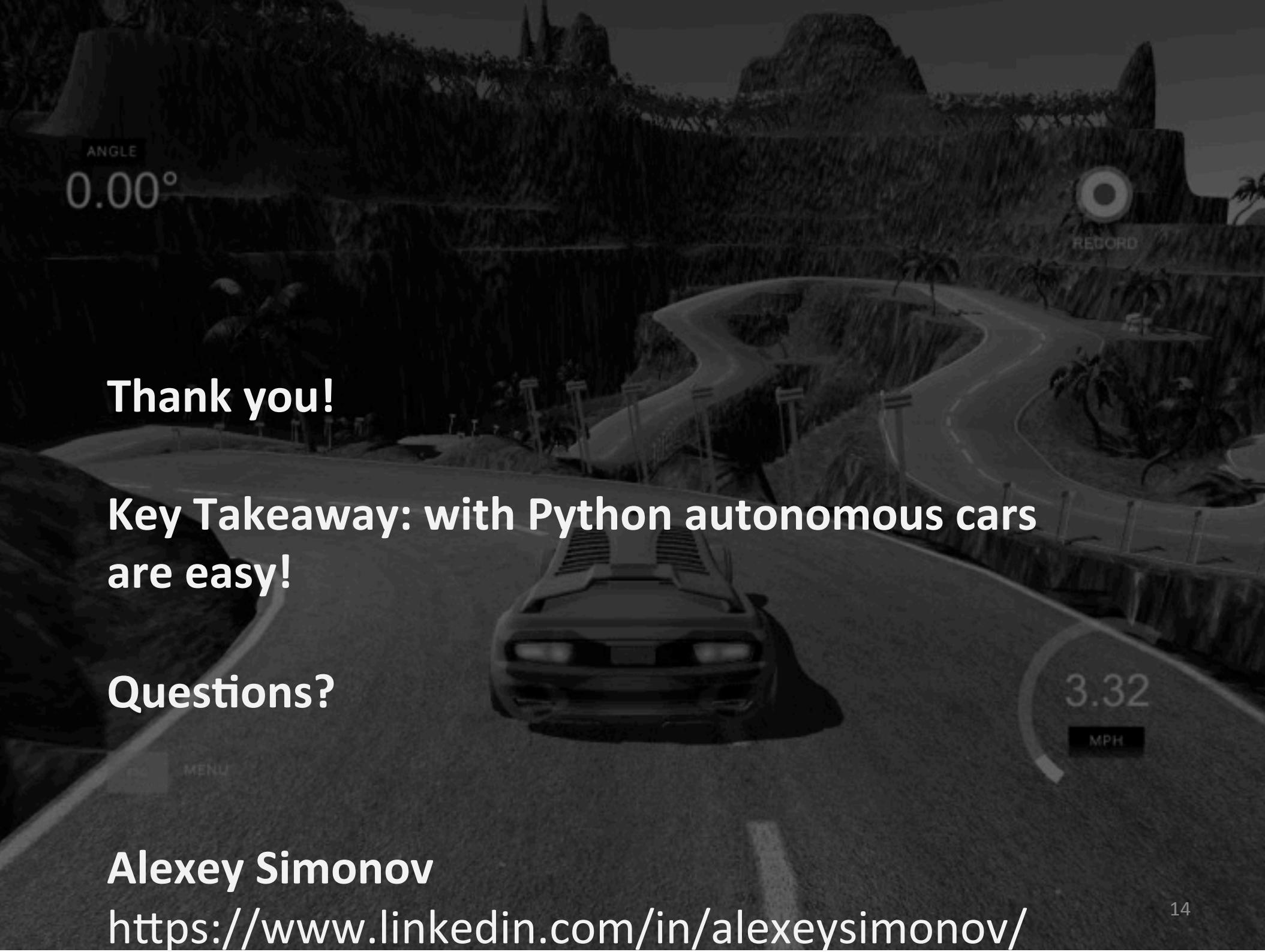
III. DEMO: Behavioural Cloning. Ways to go

There are multiple ways to go from here:

1. Use real data (one of open SDC data sets)
2. Incorporate other measurements into the model (throttle, speed, desired path)
3. Use transfer learning
4. Transfer to embedded system
 - For example Raspberry Pi. Or NVIDIA Drive PX.
 - <https://petewarden.com/2017/05/08/running-tensorflow-graphs-on-microcontrollers/>

The best resource to understand what is going on in your Deep Net and where to go from here:

<http://cs231n.github.io/>



Thank you!

Key Takeaway: with Python autonomous cars are easy!

Questions?

Alexey Simonov

<https://www.linkedin.com/in/alexseysimonov/>