Data and Society
Self-driving cars – Lecture 18

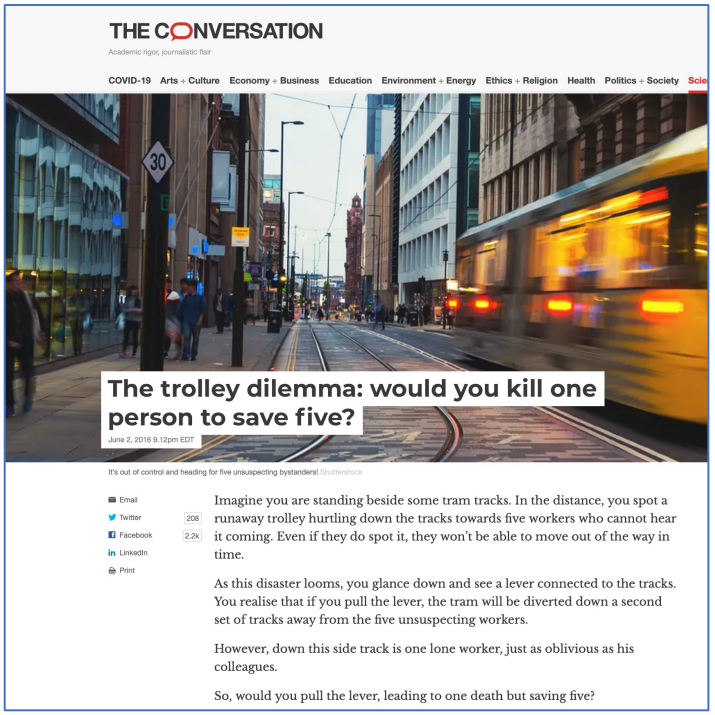
4/5/21

Today's Class

- **Choice assignment due 11:59 p.m. April 15 / Instructions in Lecture 17**
- **Last opportunity for graded presentations is April 22** – sign up before then if you have not scheduled your second presentation or would like a third opportunity (grading: best two out of three)
- Lecture / Discussion
- Student Presentations

Reading for next class

- **The Trolley Dilemma – would you kill one person to save five?,** The Conversation,
- https://theconversation.com/the-trolley-dilemma-would-you-kill-one-person-to-save-five-57111



Date	Topic	Speaker	Date	Topic	Speaker
1-25	Introduction	Fran	1-28	The Data-driven World	Fran
2-1	Data and COVID-19	Fran	2-4	Data and Privacy -- Intro	Fran
2-8	Data and Privacy – Differential Privacy	Fran	2-11	Data and Privacy – Anonymity / Briefing Instructions	Fran
2-15	NO CLASS / PRESIDENT'S DAY		2-18	NO CLASS	
2-22	Legal Protections	Ben Wizner	2-25	Data and Discrimination 1	Fran
3-1	Data and Discrimination 2	Fran	3-4	Data and Elections 1	Fran
3-8	Data and Elections 2	Fran	3-11	NO CLASS / WRITING DAY	
3-15	Data and Astronomy (Op-Ed due)	Alyssa Goodman	3-18	Data Science	Fran
3-22	Digital Humanities	Brett Bobley	3-25	Data Stewardship and Preservation	Fran
3-29	Data and the IoT	Fran	4-1	Data and Smart Farms	Rich Wolski
4-5	Data and Self-Driving Cars	Fran	4-8	Data and Ethics 1	Fran
4-12	Data and Ethics 2	Fran	4-15	Cybersecurity	Bruce Schneier
4-19	Data and Dating	Fran	4-22	Digital Rights in the EU and China	Fran
4-26	Tech in the News	Fran	4-29	NO CLASS	Fran
5-3	Wrap-up / Discussion				

Lecture

- **IoT and Self-Driving Cars**

IoT, continued

- The Internet of Things (IoT) is a deeply interconnected ecosystem of **sensors, cameras, computers, smart systems, connected devices** and other technologies.

- IoT “things”
  - share data
  - work together to make decisions
  - often operate autonomously in the background

“Smart” systems

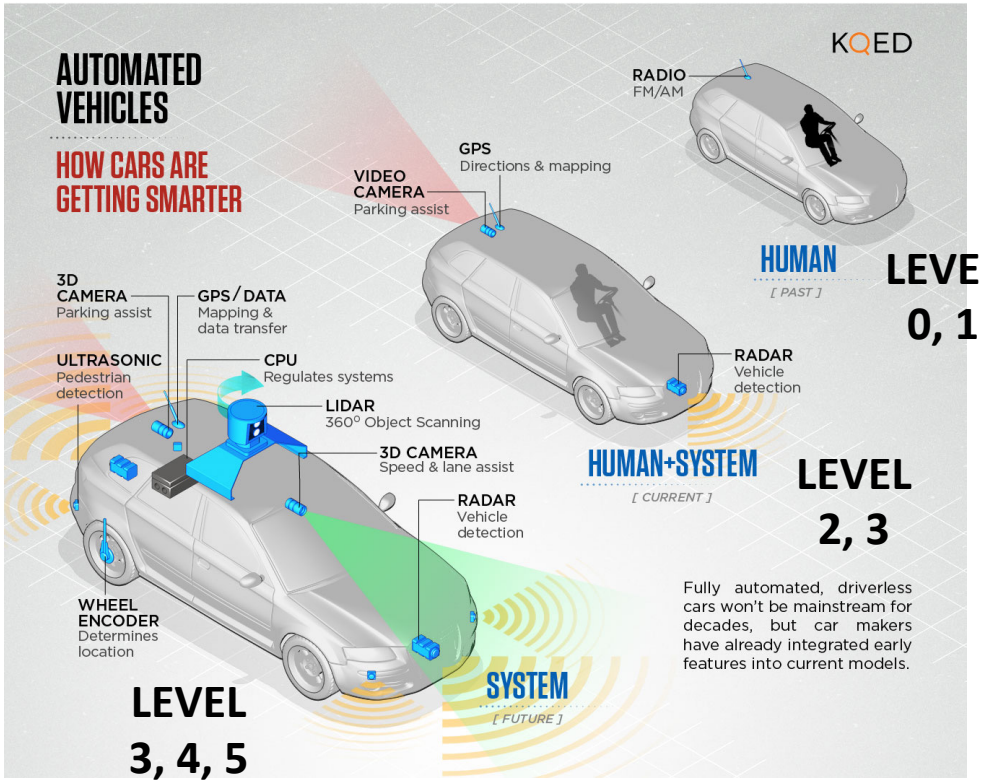
- How does a smart system function autonomously?
- How do we ensure that autonomous systems are in the public interest (safe, secure, private, minimize risk, etc.)?
- What are the broader impacts of smart IoT systems?

Developing smart systems in the public interest: Self-driving cars (Connected Autonomous Vehicles) as a Case Study

- How do CAVs work?
- Environmental impacts and sustainability
- Social effects – safety, security, privacy
- Economic implications

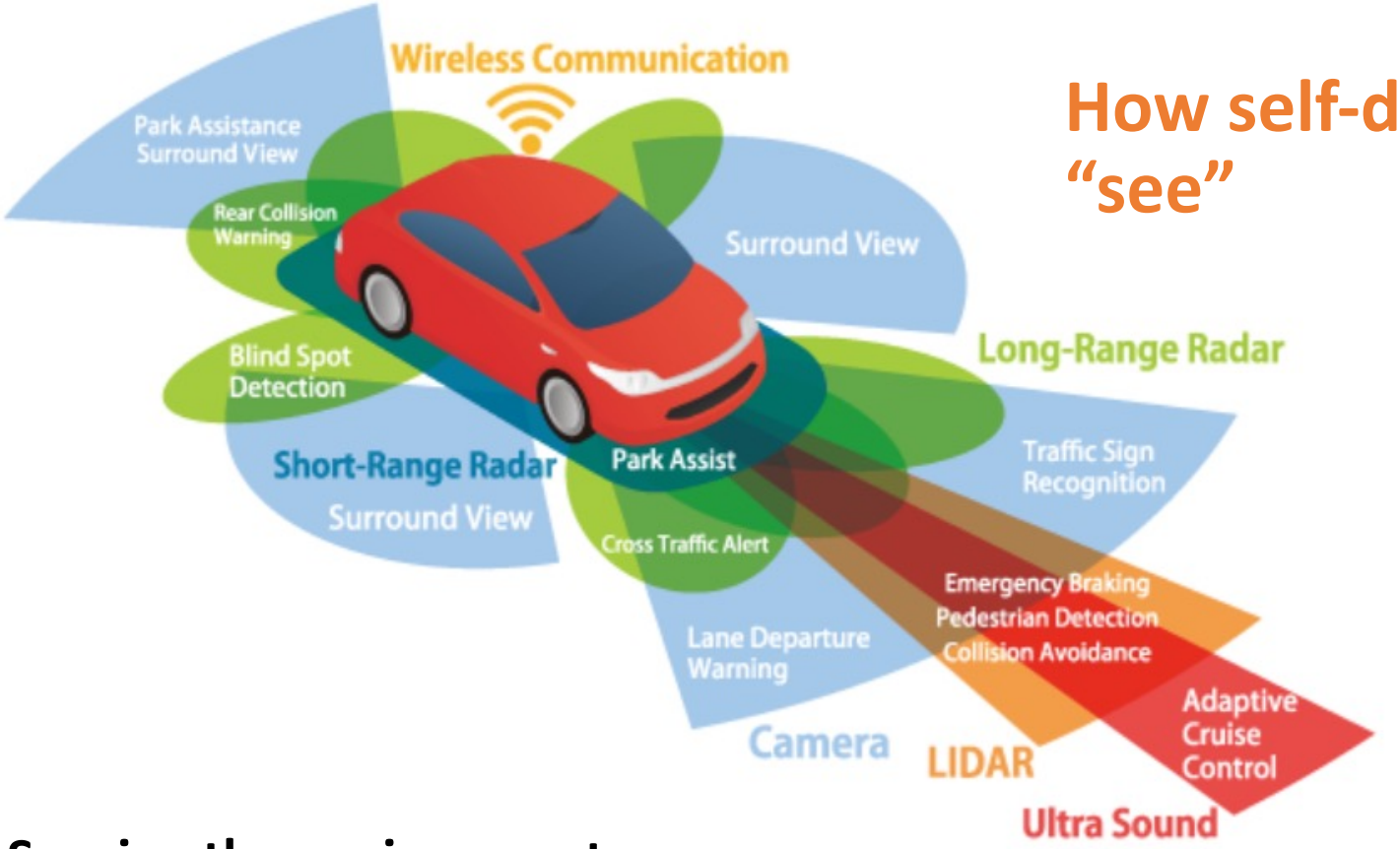
How self-driving cars work

- AV = Car + components that "see"
  + computers that model and analyze



- "Sense, plan, act"
  - **Where am I:** use positional and other information to localize itself and build a 3D image of its environment
  - **How to get there:** Find an optimal path to the destination that avoids obstacles and follows the rules of the road
  - **Drive:** Information fed to actuators which operate the car based on instructions

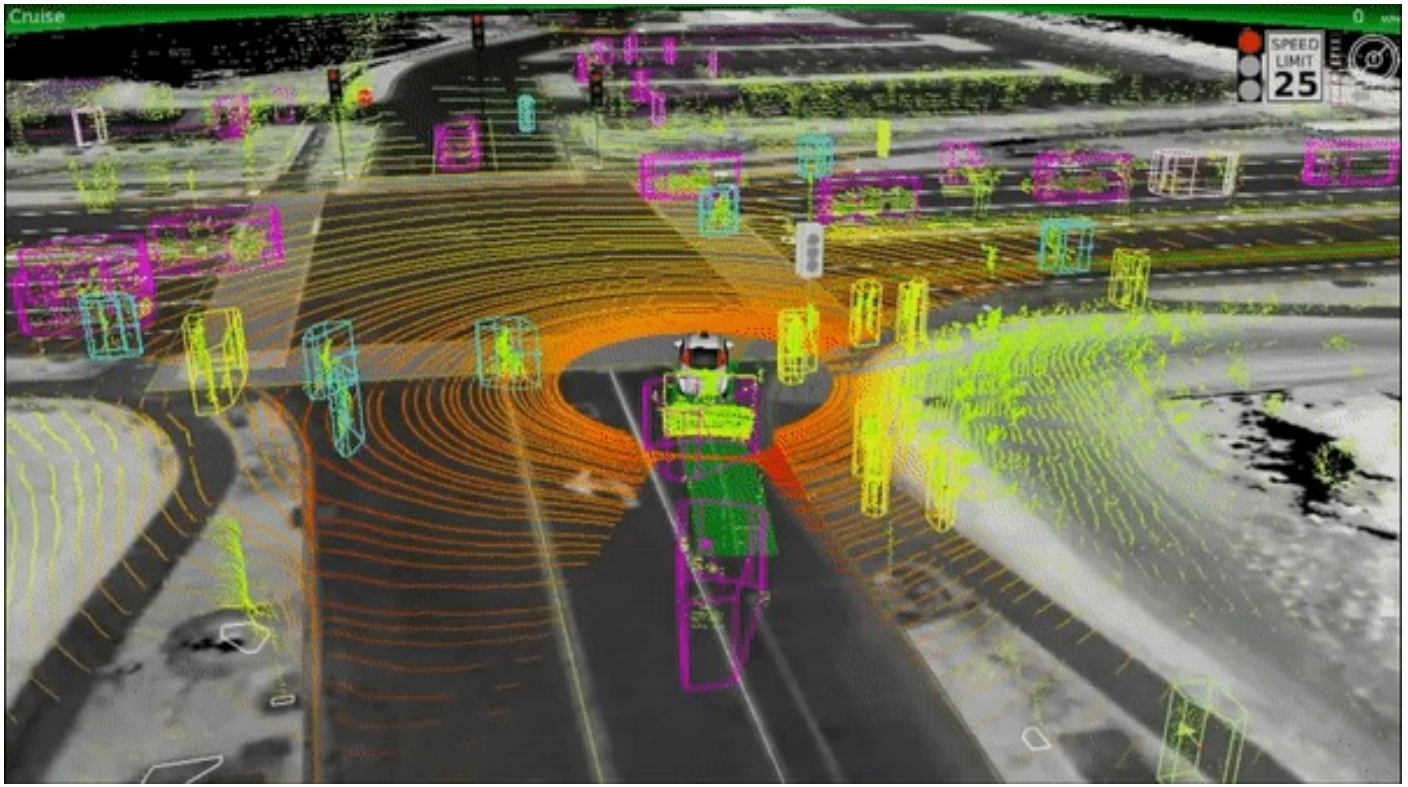
How self-driving cars "see"



Sensing the environment

- **LIDAR** (light detection and ranging mapping) → short term distance
- **Radar** (radio wave mapping) → longer distance
- **Camera** → additional detail in range
- **GPS** → positioning information
- **Inertial movement** → distance travelled, relative position
- **Ultrasound** (sound wave mapping) → obstacle detection

What self-driving cars see



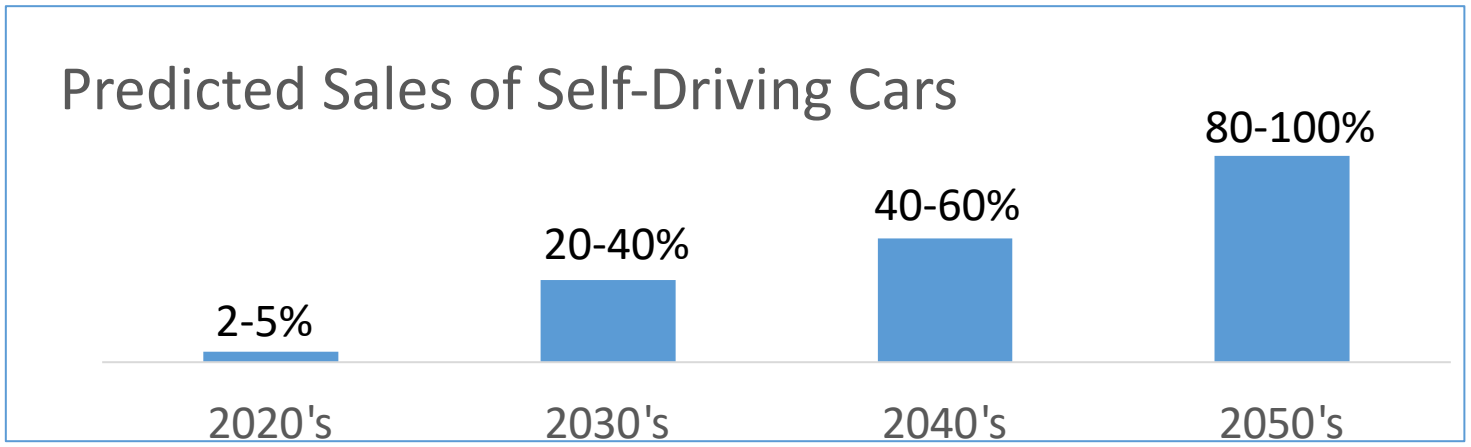
Computer control systems use AI models to interpret sensory information to identify appropriate navigation paths, obstacles, relevant signage, other cars, pedestrians, construction, etc.

Video clip from Chris Urmson's Ted Talk https://www.youtube.com/watch?v=tiwVMrTLUWg

Self-driving cars today

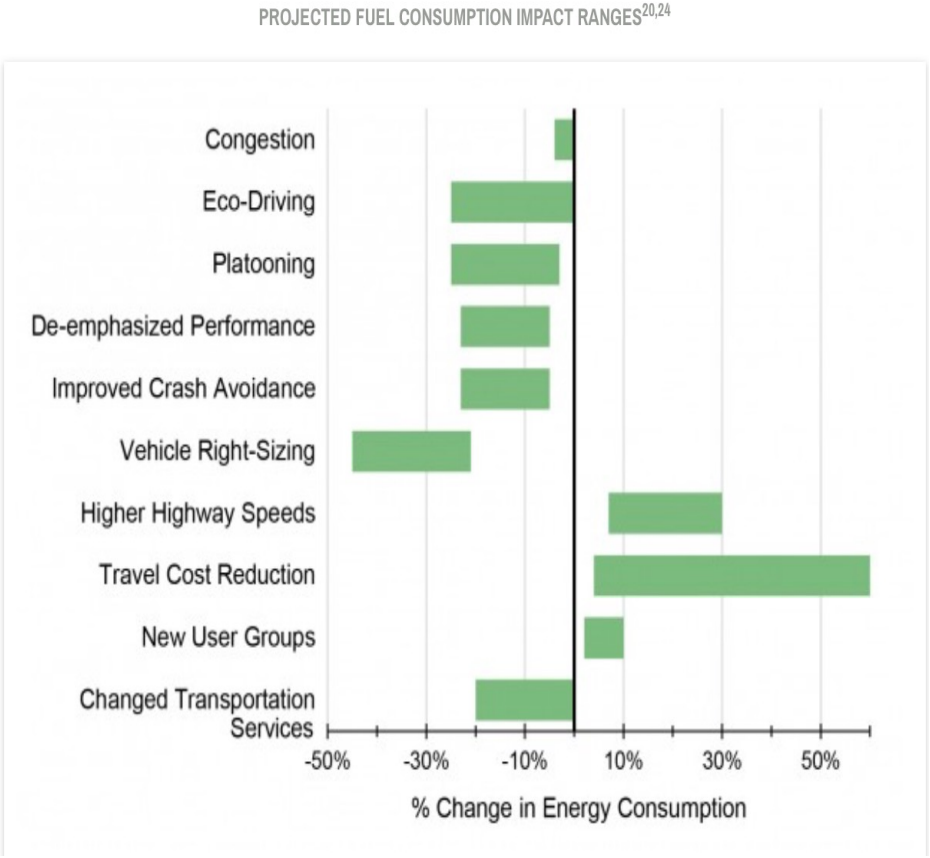
Not prevalent yet but they will be …

There were more than 1.4 billion cars on the road in 2017 [Forbes]	By 2020, there will be 10M (Level 3+) self-driving cars [Forbes]
In 2017, Americans drove over 3 trillion miles [NPR]	Waymo's self-driving car has driven over 8 million miles on public roads. [NPR, 2018]



Impact on the Environment:
Strategies for sustainability

- **Reduce emissions**
  - *Hardware:* build energy-efficient cars
  - *Software:* ecodriving
- **Design for sustainability**
  - Focus on the entire automotive lifecycle
  - Recycle / repurpose
- Promote sustainability in the transportation-related **built environment**



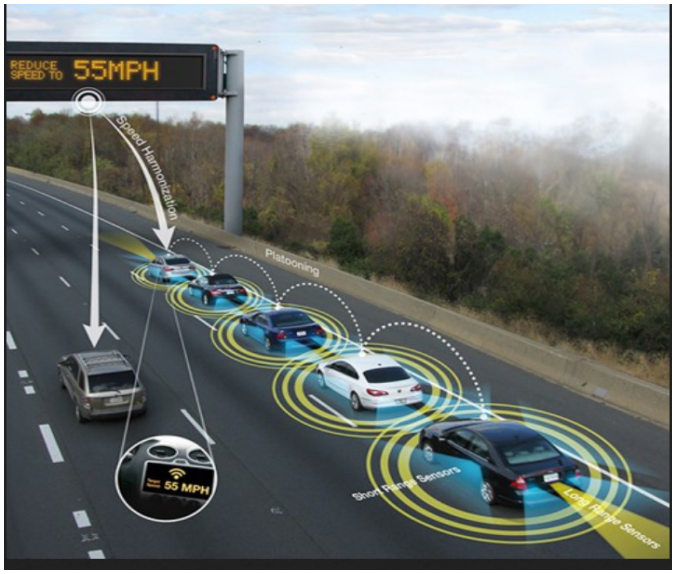
Complex trade-offs:
Which common good?

http://css.umich.edu/factsheets/autonomous-vehicles-factsheet

Impacts on the built environment

Lifestyle impacts

- Propensity to travel
- What you do in a car
- Mobility



Platooning

Adaptations in the built environment

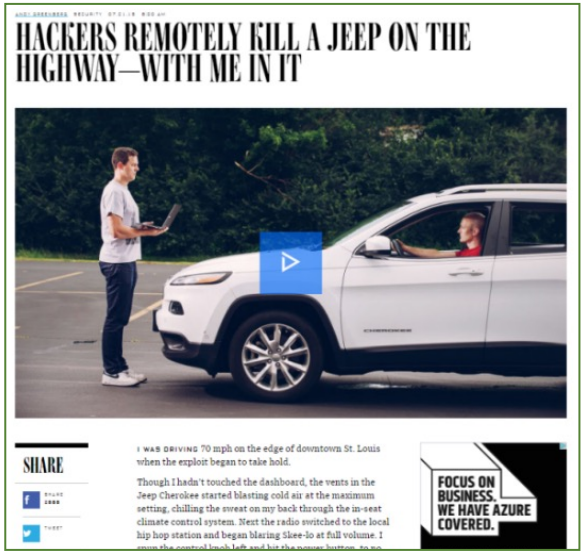
- Land-use / population density
- Highways
- Parking / garages / CAV support facilities

Parking

Social Effects: Making self-driving cars safe and secure

What can go wrong in a self-driving car?

- Sensors (GPS, cameras, LIDAR) don't work as expected
- Security and other vulnerabilities
- Unanticipated situations, etc.


HACKERS REMOTELY KILL A JEEP ON THE HIGHWAY—WITH ME IN IT

SHARE

I WAS DRIVING 70 mph on the edge of downtown St. Louis when the exploit began to take hold.

Though I hadn't touched the dashboard, the vents in the Jeep Cherokee started blasting cold air at the maximum setting, chilling the sweat on my back through the in-seat climate control system. Next the radio switched to the local hip hop station and began blaring Skee-lo at full volume. I

FOCUS ON BUSINESS. WE HAVE AZURE COVERED.

Risk of dying in a car crash over a lifetime: 1 in 102

Risk of dying in a plane crash over a lifetime: 1 in 205,552

What do we mean by “safe”?

- **How do we measure safety?**
  - Fatalities
  - Serious injuries
  - Crashes
  - Roadmanship (safety envelope violations)
  - Disengagement

Fatalities in autonomous vehicles:

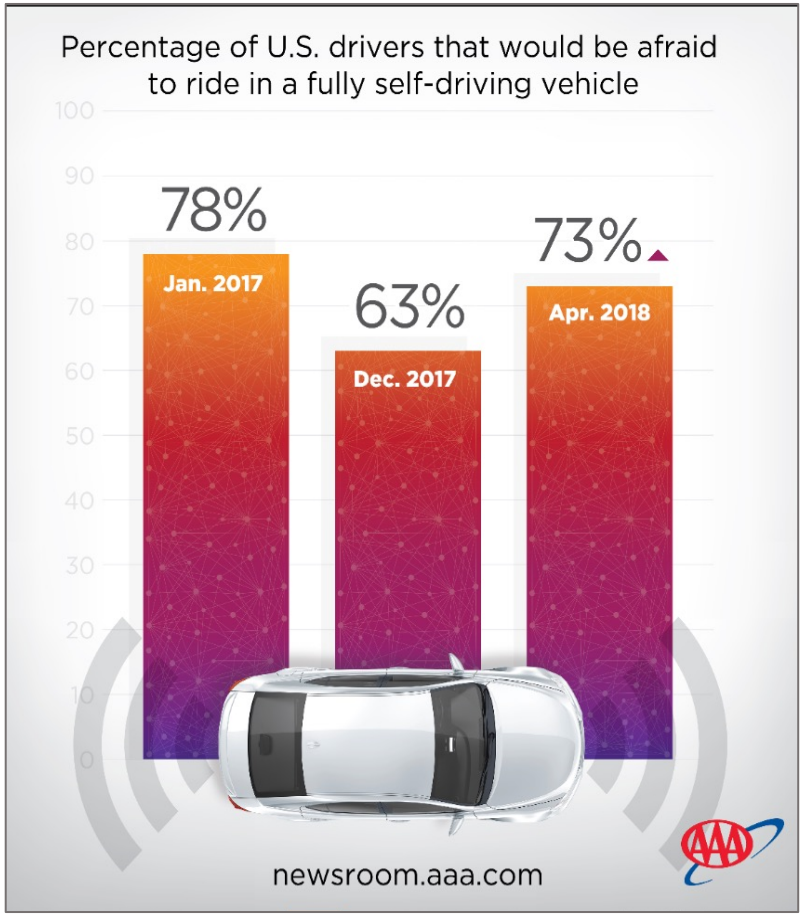
- 2016: Tesla / China
- 2016: Tesla / Florida
- 2018: Uber [Volvo] / Arizona
- 2018: Tesla / California
- 2019: Tesla / Florida

Fatalities in human-driven cars: 1.18/100M miles

https://en.everybodywiki.com/List_of_self-driving_car_fatalities

How safe do we want them to be?

- Odds of dying (2018):
  - Heart disease: 1 in 6
  - Cancer: 1 in 7
  - Opioid overdose: 1 in 98
  - Electrocution, radiation, extreme temperatures, and pressure: 1 in 12,484
  - Lightning: 1 in 180,746
- *What kills you matters*
- Mark Rosekind NHTSA: Cut in half the toll of 40,200 highway deaths annually for us to trust CAVs?

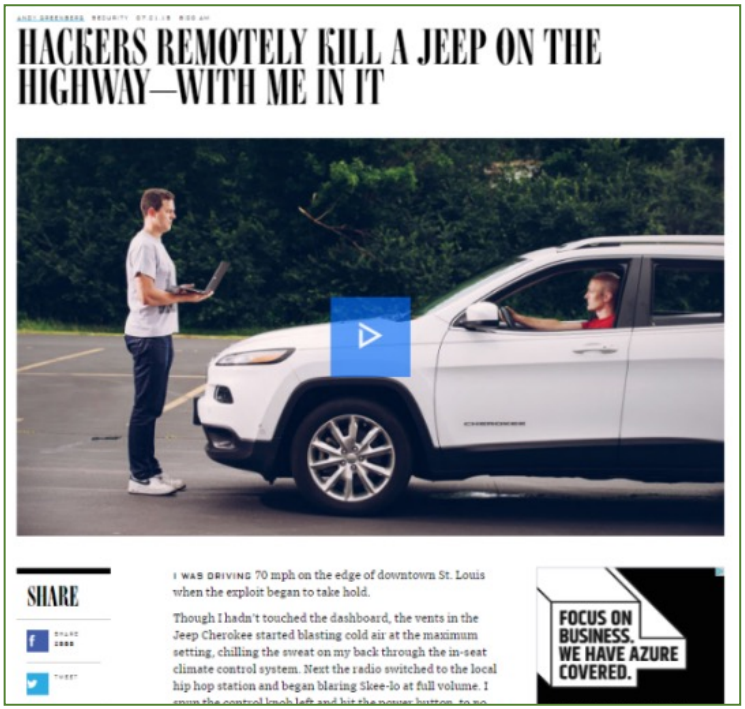


Images, graphs, and information: https://newsroom.aaa.com/2018/05/aaa-american-trust-autonomous-vehicles-slips/; https://www.huffingtonpost.com/entry/how-safe-are-self-driving-cars_us_5908ba48e4b03b105b44bc6b;; https://injuryfacts.nsc.org/all-injuries/preventable-death-overview/odds-of-dying/

New vulnerabilities: How do we make self-driving cars secure?

CAV is a "computer that drives" (Bruce Schneier) with many attack surfaces and vulnerabilities

- Password and key attacks
- Network protocol attacks
- Denial of service attacks
- Unauthorized SW updates
- Inability to deal with network outages
- Insecure exchange of information in platoons
- Hijacking, etc.



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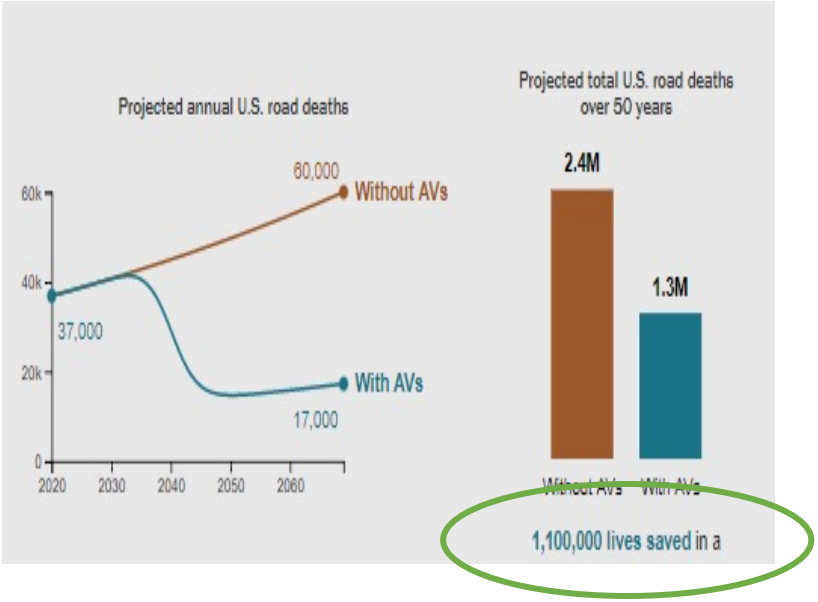
FOCUS ON BUSINESS. WE HAVE AZURE COVERED.

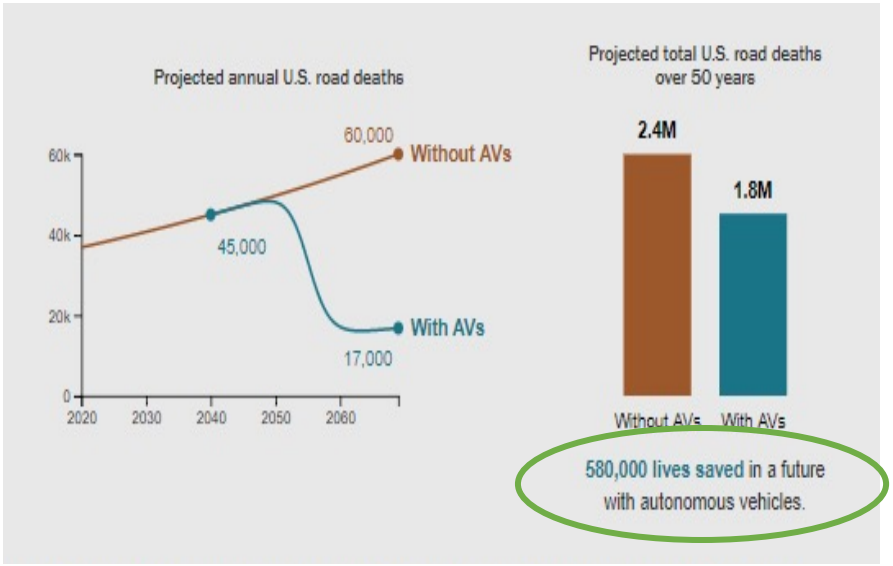
https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/

Mitigating risk – when is the best time to release autonomous technologies?

- **Scenario 1:**
  - Autonomous vehicles are **10% safer** than human drivers
  - Some consumers purchase in 2020, AVs account for 80% of miles traveled by 2060



- **Scenario 2:**
  - Roll out autonomous vehicles when they are **"nearly perfect"** in 2040
  - By 2070, autonomous vehicles account for 80% of miles traveled



Social Effects: Are CAVs a public space or a private space?

Personal data collected in CAVs may include

- Where you go
- Where you are
- What you're doing / saying
- What you listen to
- Your phone calls, texts, and website queries, etc.
- Favorite routes, stopovers, music, sites, etc.
- How you drive
- Your biometrics, etc.

Privacy policy/oversight needed

- **Collection, use, sharing of personal information**
  - Requirements for **transparency**
  - Clarification on **ownership, rights, access**
  - Ability to **review and correct**
  - **Options for consumer control** (e.g. authorization of the use of personal data only for operation and only as long as is needed)
- Development of **monitoring, enforcement** and **accountability mechanisms** to ensure compliance

Economic Impacts: How will CAVs change the economy?

- **Market leadership**
  - Traditional automotive company (**cars with smart systems**)?
  - Technology companies (**smart systems with driving hardware**)?
  - Hybrid partnerships

Google

Ford and VW

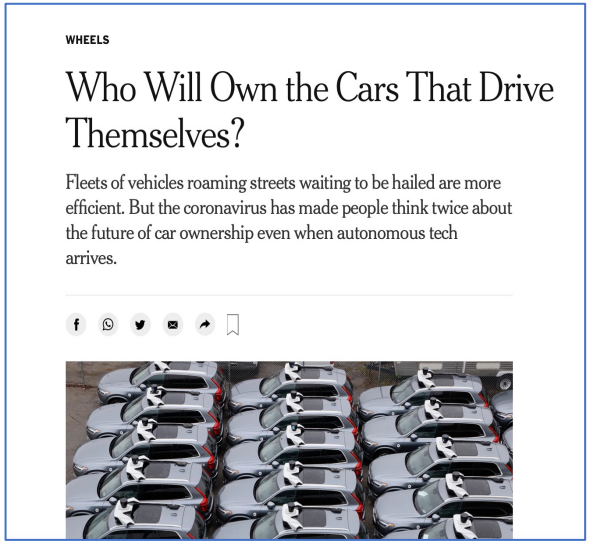
GM

- **Workforce evolution**
  - **Fewer drivers**, more “last mile delivery” solutions
  - **Evolution of auto industry workforce** to include a larger proportion of roboticists, computer scientists, engineers, materials scientists, etc.

New jobs, services and use case scenarios

- **Shift from vehicle ownership to public and private ride-sharing options**
  - **Economic impacts for related industries**
    - Insurance
    - Auto dealerships, maintenance, repair
    - Delivery
    - Long-haul transportation

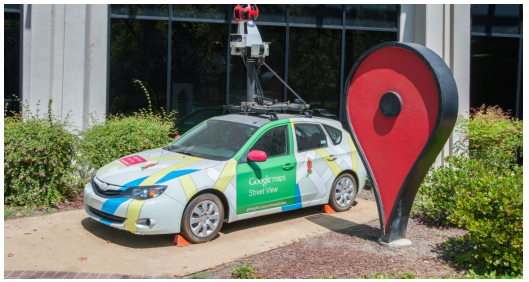
- **Expanded and new uses for CAVs:**
  - Auto concierge services
  - Entertainment services
  - Dynamic surveillance



WHEELS

Who Will Own the Cars That Drive Themselves?

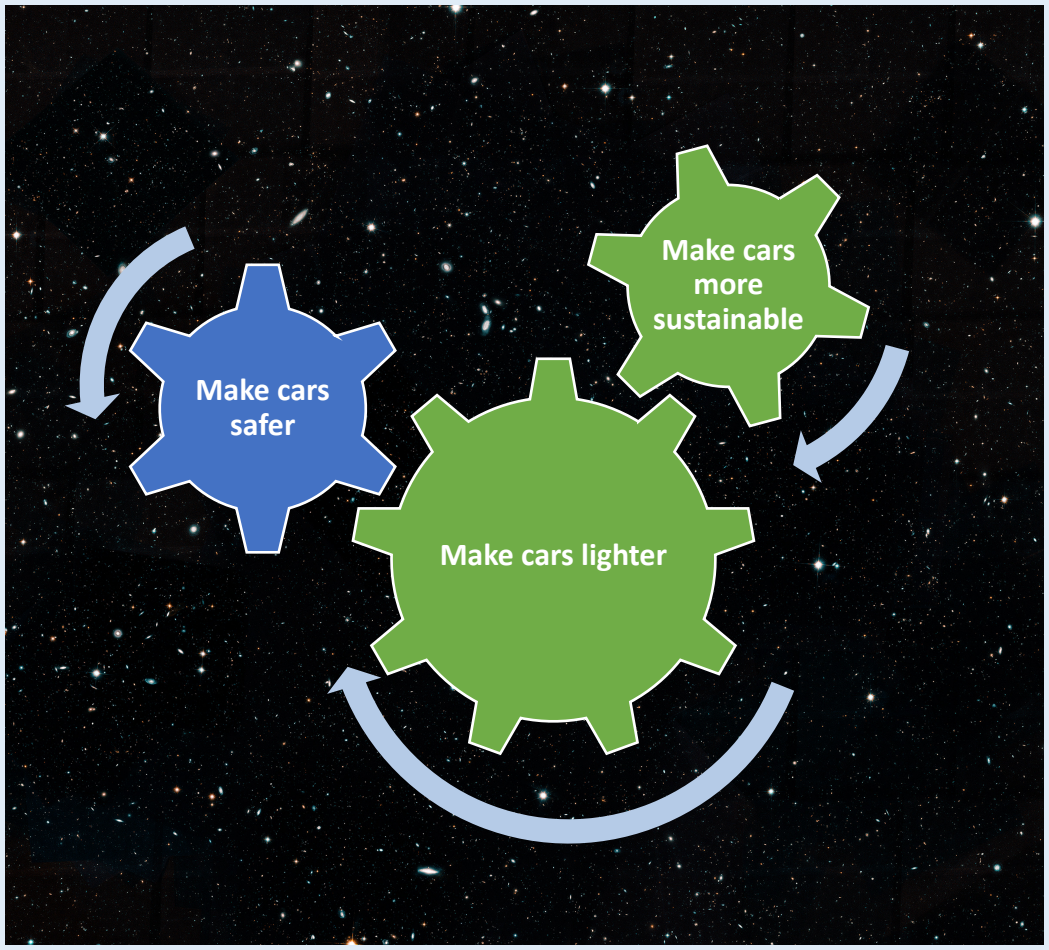
Fleets of vehicles roaming streets waiting to be hailed are more efficient. But the coronavirus has made people think twice about the future of car ownership even when autonomous tech arrives.



https://www.nytimes.com/2020/05/29/business/ownership-autonomous-cars-coronavirus.html
https://www.motoringresearch.com/car-news/street-view-cars-10-million-miles/

CAV Development: Where do we go from here?

- **Developing IoT products and services in the public interest involves competing strategies and goals**
  - What's most important?
  - How do we balance the trade-offs?



- Technology that promotes the common good must be a community effort -- **not one sector's job**

Development of CAVs and other IoT devices/systems in the public interest will require broad-based approach

Multiple Players

- Government
- Business
- The Public
- Academia

Multiple Strategies

- Public-focused **policy and legislation**
- **Responsible design** – architected for safety, security, privacy, protections
- **Transparency** about risks and benefits
- Promotion of **safe use** and practice
- Public-focused **education** and **innovation**

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- https://www.flickr.com/photos/williamhook/38109880456, Fletcher6, https://commons.wikimedia.org/wiki/File:E-ZPass_Toll_Plaza_-_Spaulding_Turnpike.jpg
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- https://www.brookings.edu/blog/techtank/2019/06/20/what-are-the-proper-limits-on-police-use-of-facial-recognition/

References 2

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- https://www.landmarkdividend.com/self-driving-car/
- From https://www.youtube.com/watch?v=tiwVMrTLUWg
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- https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway
- https://www.nssga.org/making-case-infrastructure-investment/cars-in-traffic/
- https://www.missourilawyers.com/blog/fatal-car-accident-odds/
- https://www.rand.org/blog/articles/2017/11/why-waiting-for-perfect-autonomous-vehicles-may-cost-lives.html
- https://www.theatlantic.com/technology/archive/2019/02/the-latest-self-driving-car-statistics-from-california/582763/

Presentations

Upcoming Presentations

April 8

- "**Vaccine passports pose ethical thicket for Biden Administration**," Politico, https://www.politico.com/news/2021/03/17/vaccine-passports-ethics-biden-administration-476384
- "'**This is bigger than just Tinmit': How Google tried to silence a critic and ignited a movement**". Fast Company, https://www.fastcompany.com/90608471/timnit-gebru-google-ai-ethics-equitable-tech-movement

April 12

- "**What a gambling app knows about you**", New York Times, https://www.nytimes.com/2021/03/24/technology/gambling-apps-tracking-sky-bet.html
- "**Can computer algorithms learn to fight wars ethically?**", Washington Post, https://www.washingtonpost.com/magazine/2021/02/17/pentagon-funds-killer-robots-but-ethics-are-under-debate/?no_nav=true&tid=a_classic-iphone

April 15

- "**New wave of hacktivism adds twist to cybersecurity woes**," Reuters, https://www.reuters.com/article/uk-cyber-hacktivism-focus/new-wave-of-hacktivism-adds-twist-to-cybersecurity-woes-idINKBN2BH3I3

- "**Clop ransomware gang breaches University of Colorado and University of Miami**," Security Magazine, https://www.securitymagazine.com/articles/94891-clop-ransomware-gang-breaches-university-of-colorado-and-university-of-miami

Need Volunteers – 4/19

- "**This cuffing season, it's time to consider the privacy of dating apps**", Brookings Institution, https://www.brookings.edu/blog/techtank/2020/11/20/this-cuffing-season-its-time-to-consider-the-privacy-of-dating-apps/ (Jeff H.)

- "**How private is your on-line dating data?**", Consumer Reports, https://www.consumerreports.org/privacy/how-private-is-your-online-dating-data/ (Sola S.)

Today's Presentations

April 5

- "**Your self driving car isn't ready. Smarter roads might change that**," CNN Business, https://www.cnn.com/2021/03/05/cars/cavnue-self-driving-lanes/index.html (Greg)

- "**Waymo simulated real world crashes to prove its self-driving cars can prevent deaths**", The Verge, https://www.theverge.com/2021/3/8/22315361/waymo-autonomous-vehicle-simulation-car-crash-deaths (Nick)