




CSE 352: Self-Driving Cars



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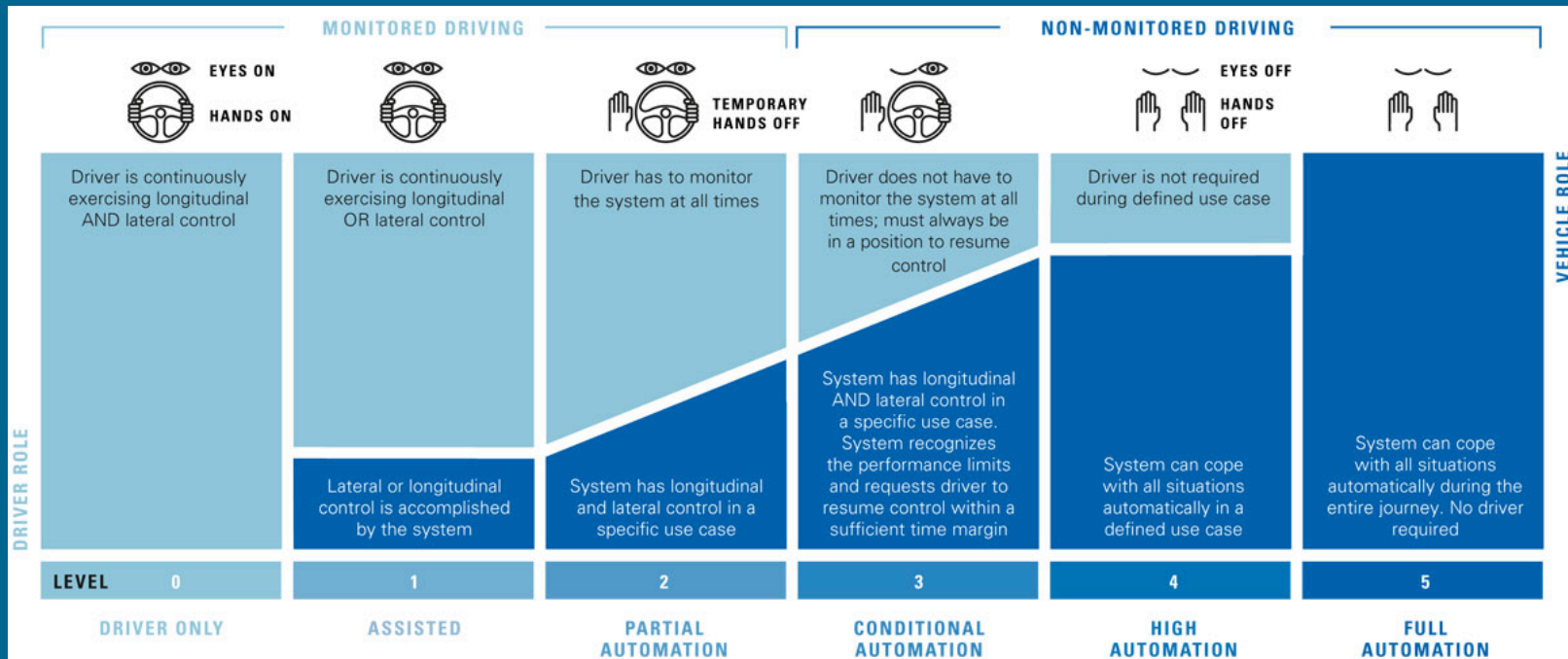


What are Self-Driving Cars

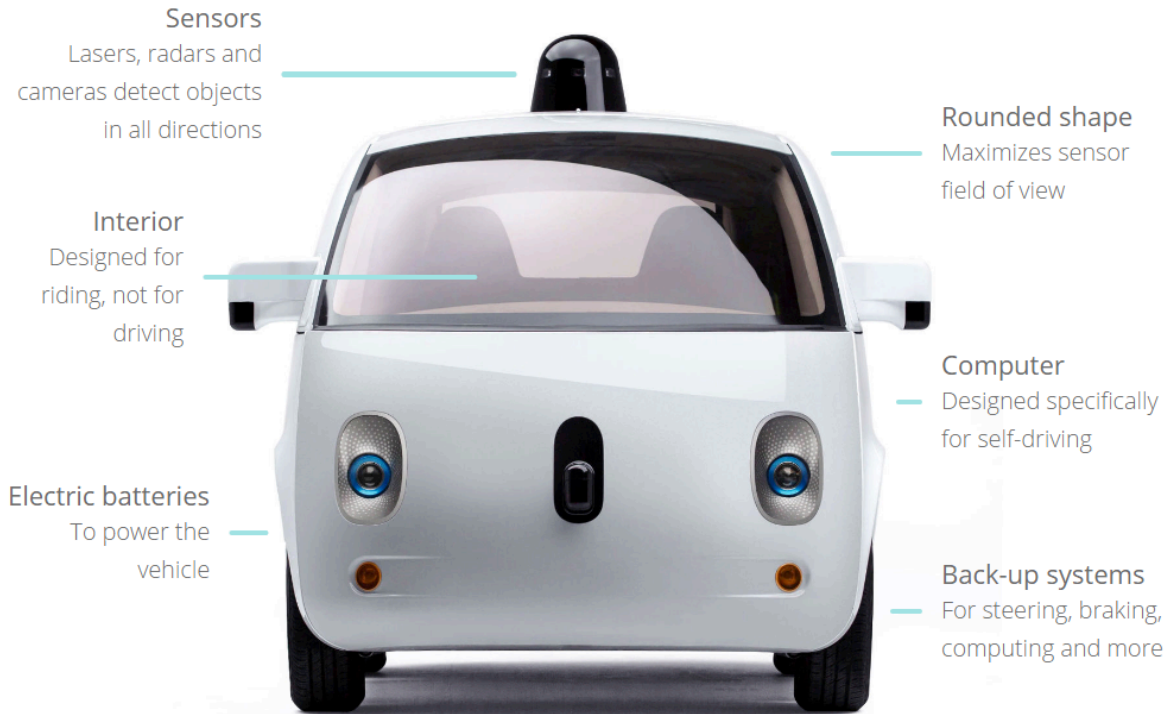
A self-driving car, also called autonomous car and driverless car, is a vehicle that is capable of sensing its environment and navigating without human input.



Classification

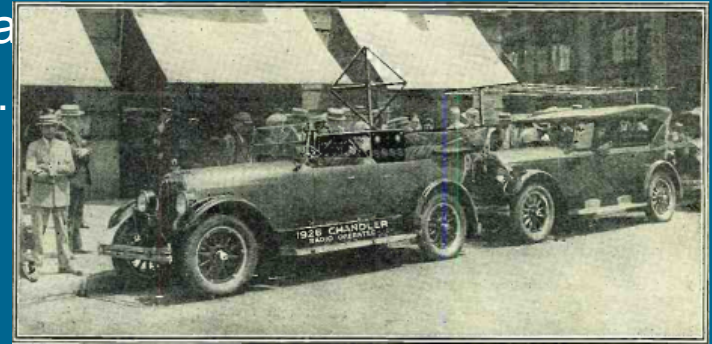
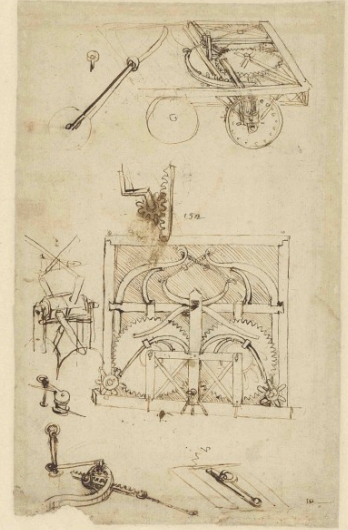


Self-Driving Car Layout



Early Automatization

- Subject of fascination for millennia.
- In 1478, Leonardo Da Vinci sketched the mechanism of a cart that would go through a predetermined path.
- Evidence of concrete experiments can be traced to at least the 1920s (i.e. Linriccan Wonder).



Early Automatization Cont'.

- Further research and progress ensued in the following decades.
- In 1987, the first truly self-driving car was developed.
 - Built at Bundeswehr University Munich (*Universität der Bundeswehr München*)
 - Used Saccadic Vision, Probabilistic approaches and parallel computers.



Algorithm

- GPS information enables the vehicle to locate itself.
- Additional data obtained from the sensors is used to refine the car's location and develop a 3D image of the its environment.
- The data is then fed to the car's control system, which determines the next move.
- This process is repeated constantly in a loop many times per second till the car reaches its final destination.

Control System



Most Control Systems implement a deliberative architecture to make decisions.

Deliberate Architecture

How It Works?

1. Maintains an internal map of the car's environment.
2. Uses that map to decide what is the best path to their destination among possible paths.
3. Breaks the decision into multiple commands.
4. Sends the commands to the car's actuators which controls the car's steering, braking, etc.

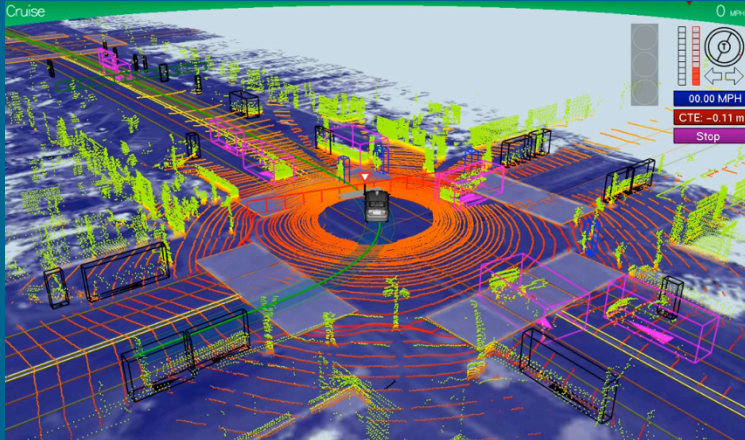
Computer Vision

- Edge detection
- Feature recognition



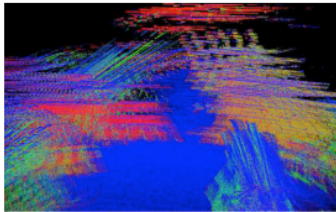
Computer Vision

- Lane detecting
- Driving near human controlled vehicles add complications

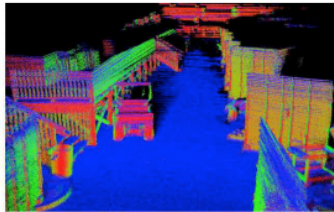


Computer Vision

- Noise Reduction - Sensors can be calibrated automatically to greatly minimize noise
- Some information is unimportant and should be ignored



(a) Horribly uncalibrated sensor.

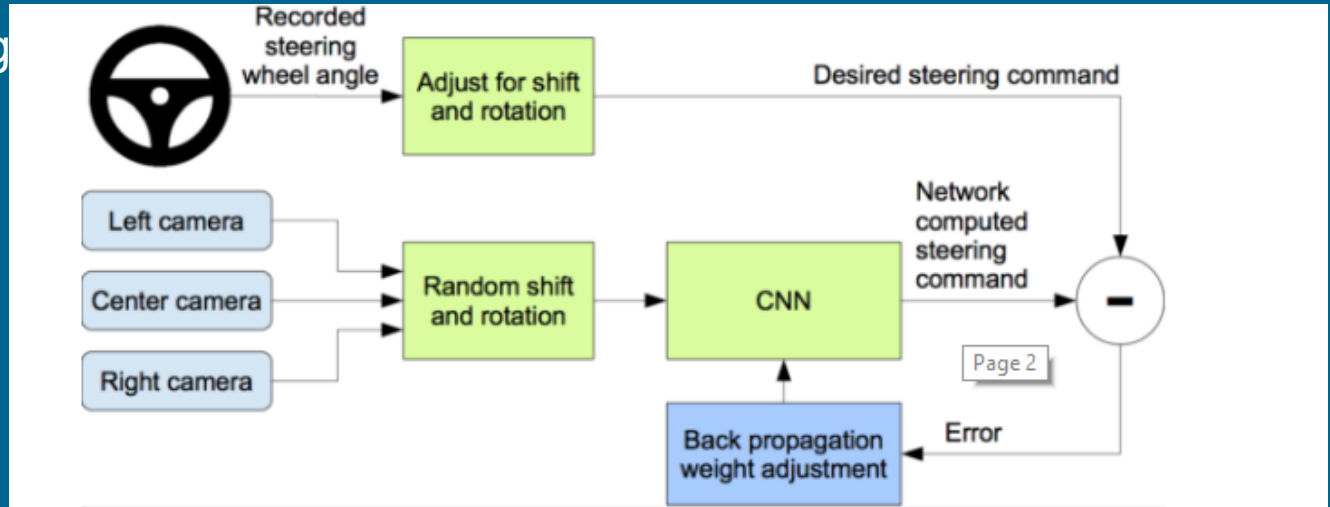


(b) After 300 iterations of optimization



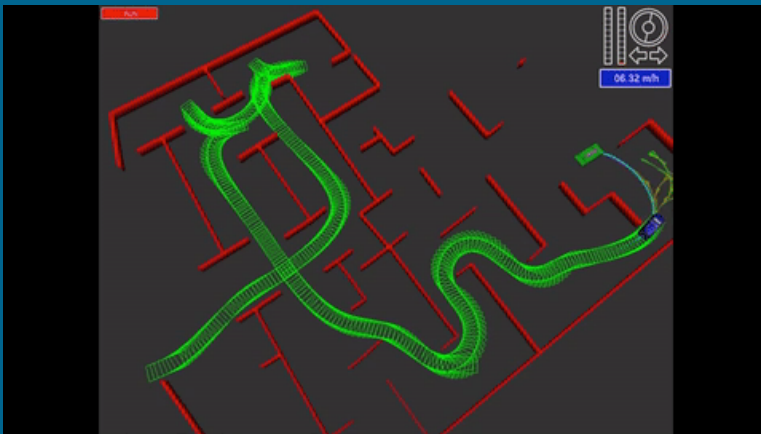
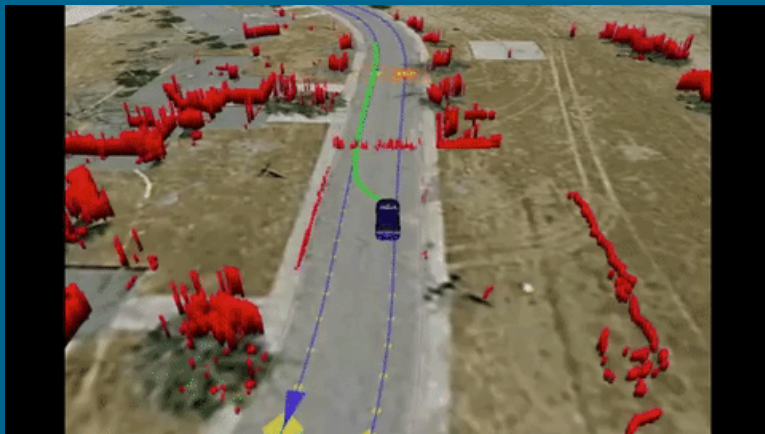
Neural Networks

- Convolutional neural networks
- Directly map camera data to steering wheel
- Human training



Navigation

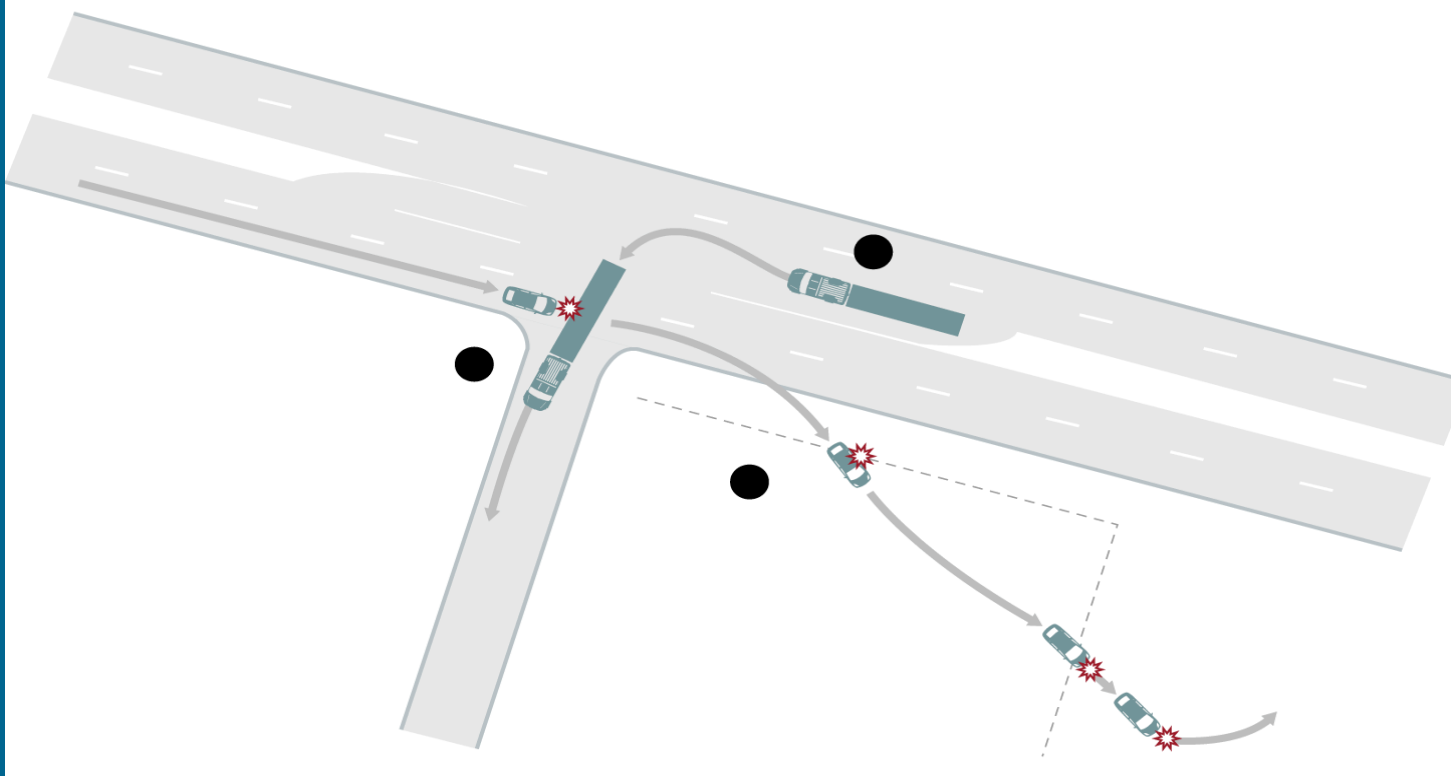
- Altered A* Search Algorithm



Articles / Problems With Cars

- Unpredictable Humans
- Line detection
- Detours and rerouted roads
- Dark outlines
- Decision making

Tesla Semi-autonomous Car Incident



Tesla Semi-autonomous Car Incident

Driver and crash avoidance system unable to detect an obstacle due to a brightly lit sky

Tesla stated that its crash avoidance system only worked when both its radar and computer vision agreed there was an obstacle

Vehicle was not intended to be “hands-free”

Causing doubt among public

Google's Self Driving Car

- Crash occurred due to reckless driving from a human driver running a red light
- Its detection system anticipated the oncoming car to run the light
 - Applied brakes
- Test driver took over, and car collided with other driver
- Consider this: Human Judgment or Computer Automated Control
 - Can we trust computer systems to make split second decisions?
 - Should self driving cars be on the same road with humans?

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