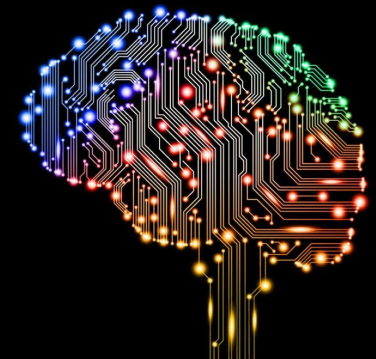




# Real-time Autonomous Vehicle

Krishna Teja Chitty  
11/08/18



# *What is Real-time performance ??*

*Meeting the deadline*



*Not fast execution*



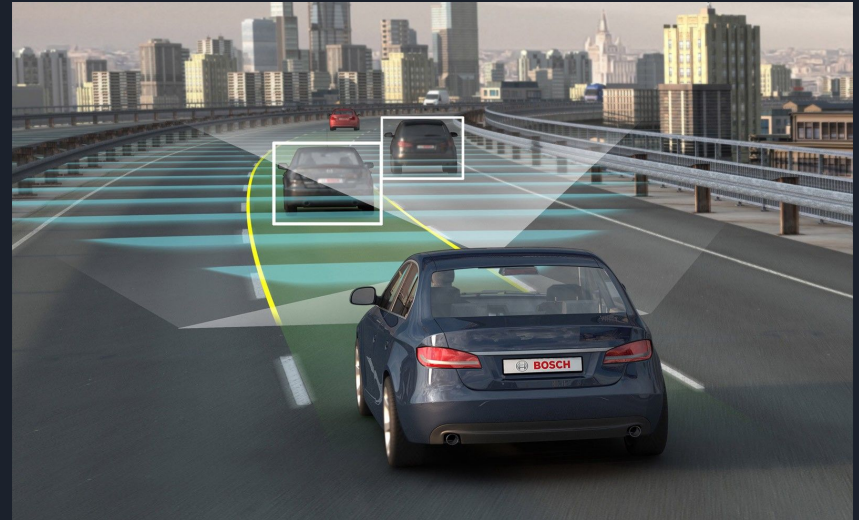


# Review

- **Real-Time Monitoring:** Reporting the state of an environment within a very small duration, ensuring that the reported state of the environment matches the actual state at the time of the report's delivery.
- **Real-Time Data Processing:** Collecting and responding to data from the environment before the environment conditions change

# Autonomous Car

Autonomous car, commonly known as driverless car, self-driving car is a vehicle which is capable of detecting its environment and navigating without human interference



Source:  
<https://medium.com/the-mission/the-road-ahead-autonomous-vehicle-s-startup-ecosystem-3c91d546673d>



Google

Uber



Source: Google, Uber

## GPS (global positioning system)

combined with readings from tachometers, altimeters and gyroscopes to provide the most accurate positioning

**Cost: \$80-\$6,000**

## Ultrasonic sensors

to measure the position of objects very close to the vehicle

**Cost: \$15-\$20**

## Odometry sensors

to complement and improve GPS information

**Cost: \$80-\$120**

## Central computer

analyzes all sensor input, applies rules of the road and operates the steering, accelerator and brakes

**Cost: ~50-200% of sensor costs**

## Lidar (light detection and ranging)

monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.)

**Cost: \$90-8,000**

## Video cameras

monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.) and read traffic lights

**Cost (Mono): \$125-\$150**

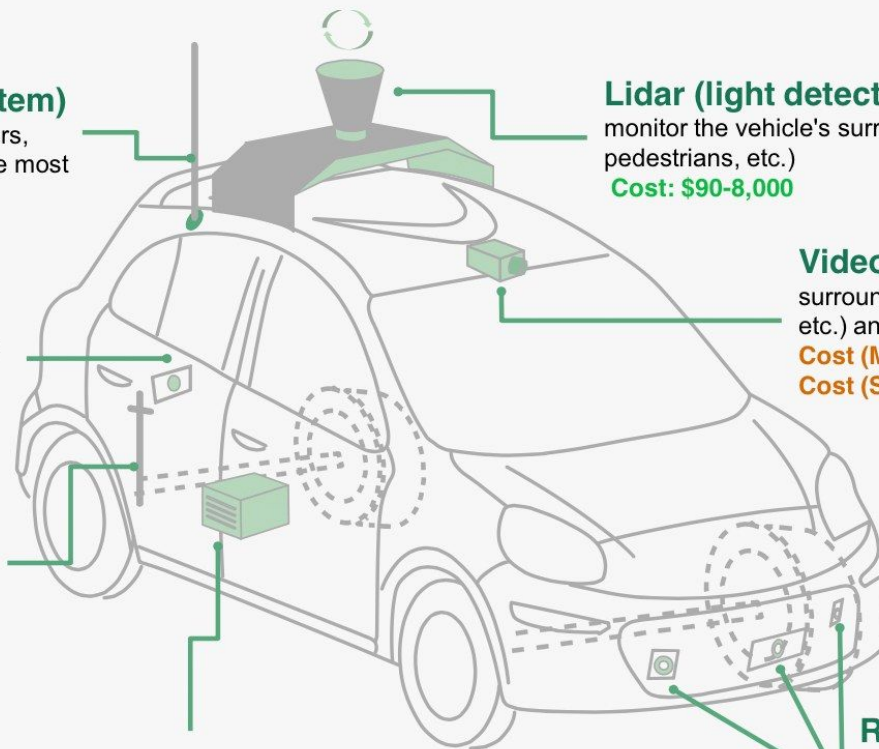
**Cost (Stereo): \$150-\$200**

## Radar sensors

monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.)

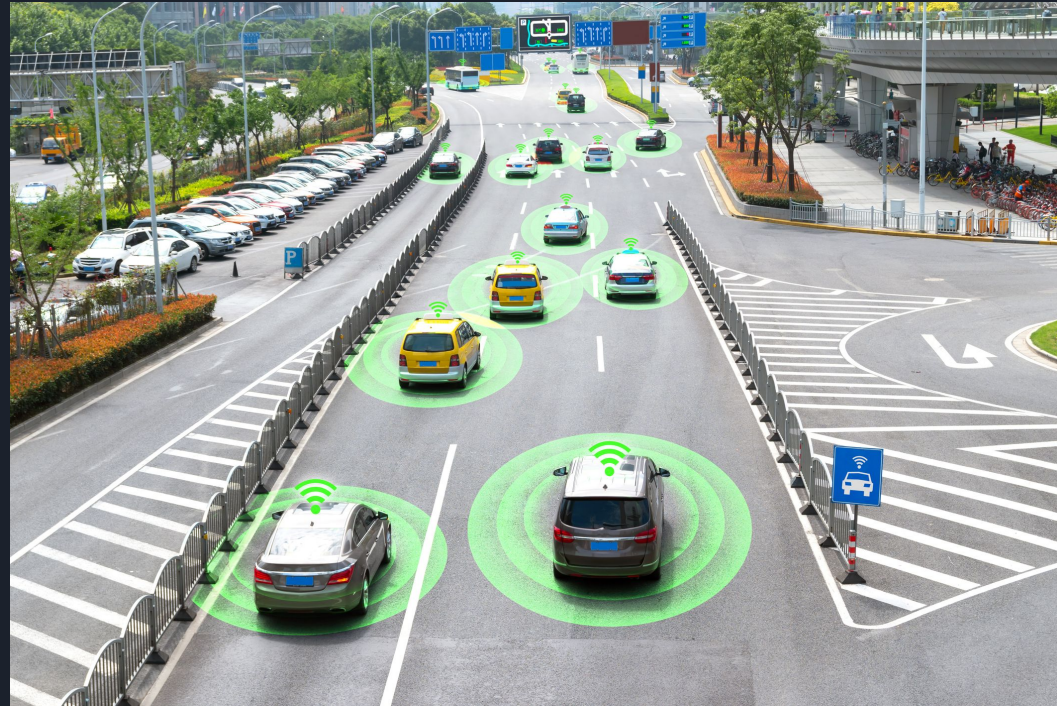
**Cost (Long Range): \$125-\$150**

**Cost (Short Range): \$50-\$100**

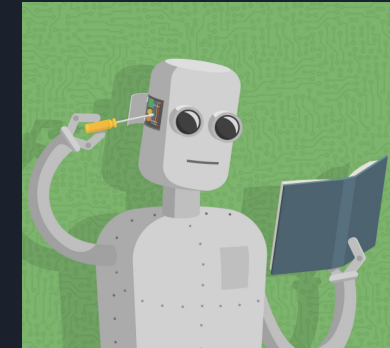
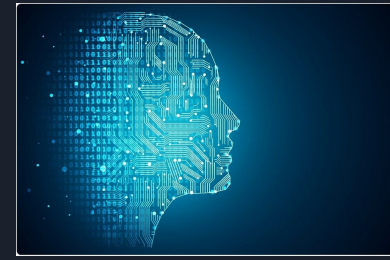


# What is Real-time performance in Autonomous Car ?

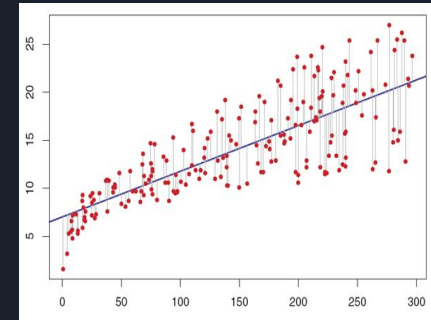
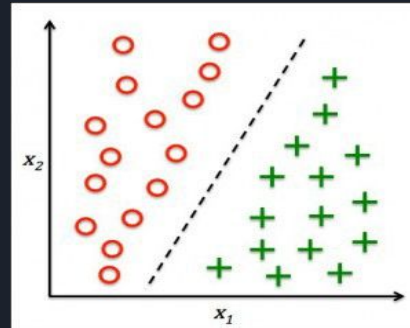
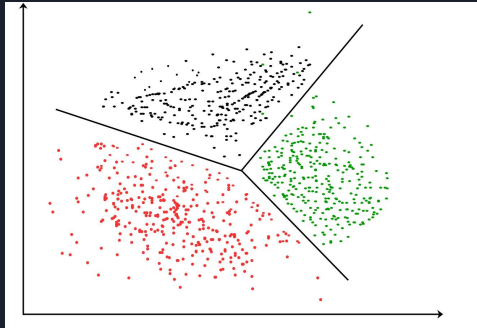
- Navigating through the environment vehicle properly
- Avoiding accidents



# What is Artificial Intelligence ??

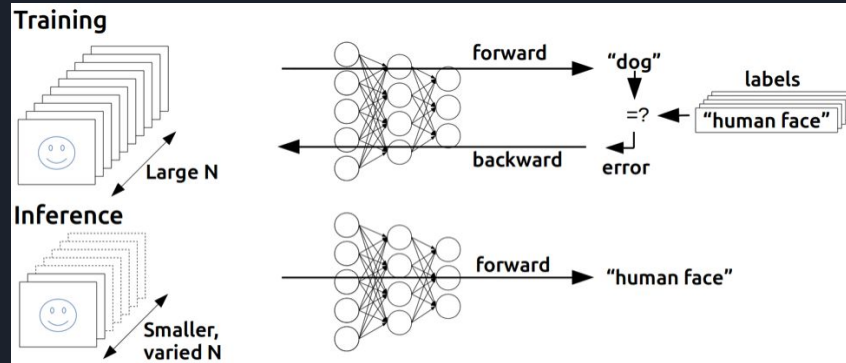


- A technique which enables computers to emulate human behavior in terms of sensing, acting, adapting etc.
- Machine Learning: The subset of Artificial Intelligence where the accuracy of algorithm is improved when they are exposed to more data over time

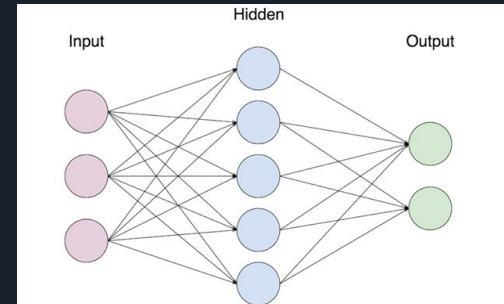


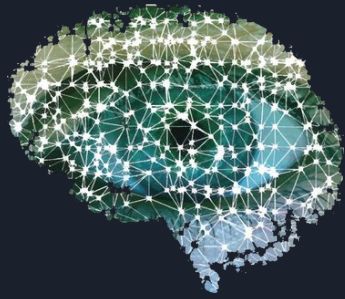


# Training vs Inference



- Deep Learning: The subset of Machine Learning which Neural networks to learn the patterns in data

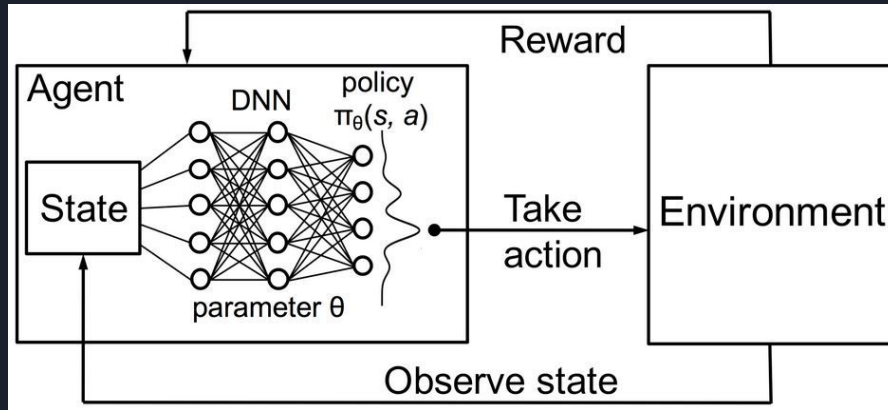




# Reinforcement Learning

- Interacting with the environment and learning from it to achieve the goal

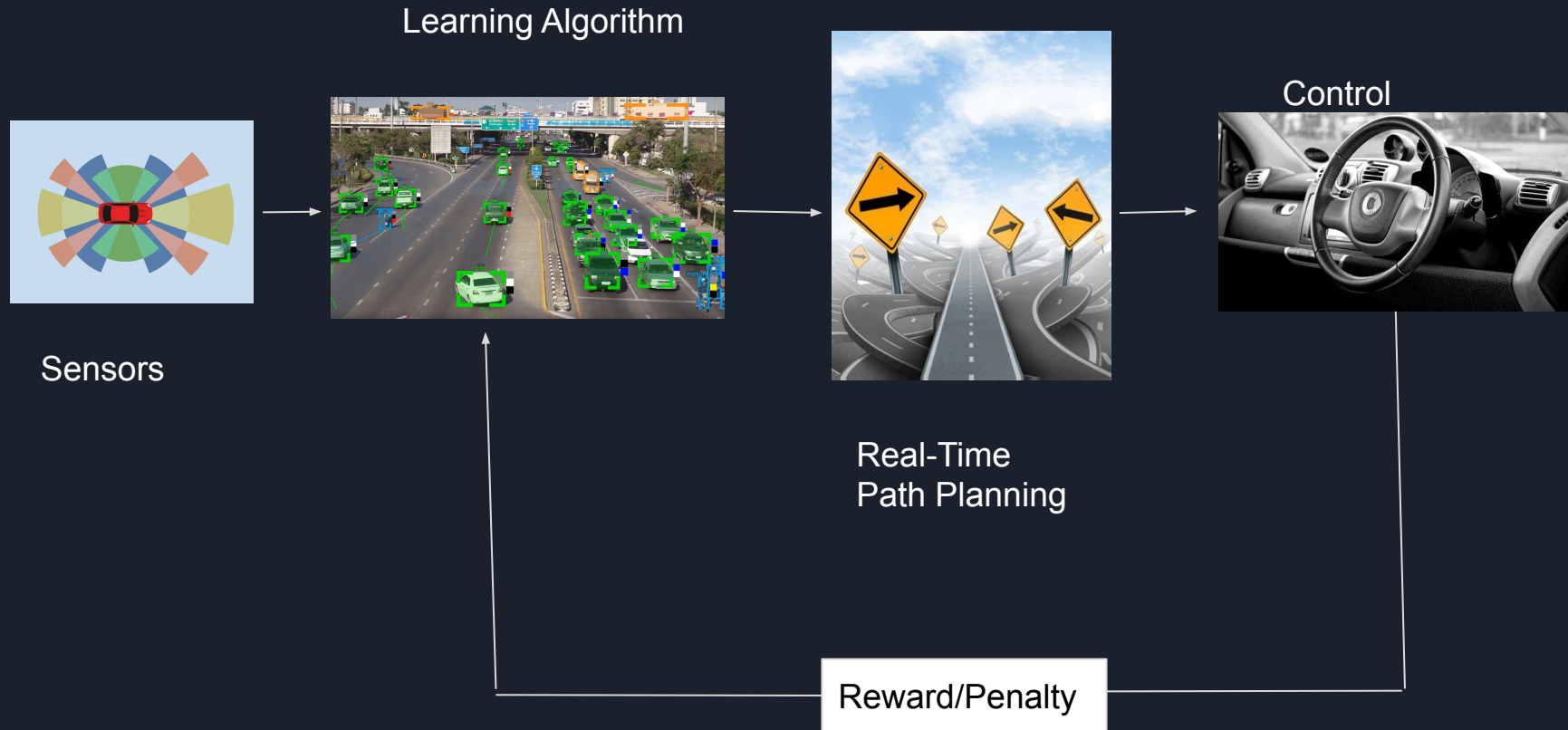
Example: AlphaGo





Activity: Try to come up with a feedback mechanism which has sensors, actuators that uses “Reinforcement Learning” Technique

# Feedback Mechanism



# Recent Incident



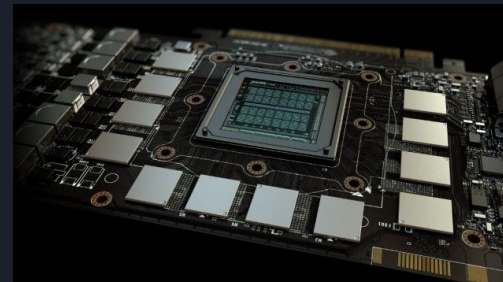
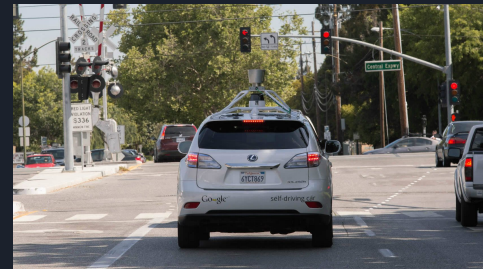
# Reasons for accidents ??

- Low accuracy of the Algorithm
- High accuracy, but couldn't deliver in time



# Parameters w.r.t Real Time System

- Accuracy: Predicting to take proper actions at the right moment
- Computational Power: Amount of work done to get the result
- Latency: Delivered the accuracy before the deadline







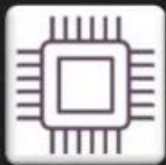
Accuracy

Computation Cost

Low	High
Low	Low
High	High
High	Low

Which is more desirable ??

375ms



7ms





## Conclusion

Artificial Intelligence + Efficient hardware =>  
Real-Time Autonomous Vehicle



# References

- <https://selfdrivingcars.mit.edu/>
- V. Sze, Y.-H. Chen, T-J. Yang, J. Emer, “Efficient Processing of Deep Neural Networks: A Tutorial and Survey”, arXiv, 2017
- <https://www.theverge.com/2018/6/22/17492320/safety-driver-self-driving-uber-crash-hulu-police-report>
- <https://ai.stanford.edu/~nilsson/MLBOOK.pdf>
- <http://images.nvidia.com/content/volta-architecture/pdf/volta-architecture-whitepaper.pdf>
- <https://medium.com/the-mission/the-road-ahead-autonomous-vehicles-startup-ecosystem-3c91d546673d>
- Google, Uber, Nvidia
- <https://devblogs.nvidia.com/inference-next-step-gpu-accelerated-deep-learning/>