

Vehicle Navigation with Neural Networks

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Introduction

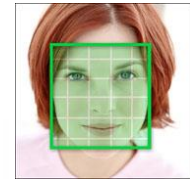
- ▶ Many thousand deaths every year
- ▶ Self-Driving Cars
- ▶ Neural Networks
- ▶ Model used to make predictions on data
- ▶ Learn from training data



Applications Today

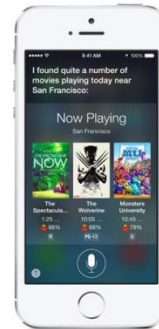


- ▶ Image processing and classification

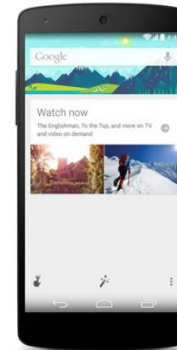


- ▶ Speech Recognition

Apple Siri



Google Now



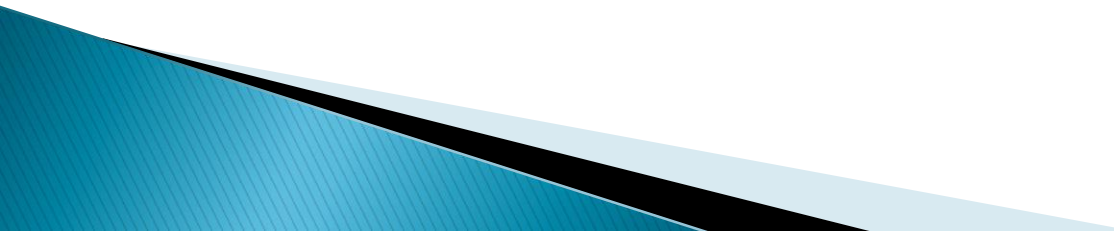
Windows Cortana



- ▶ Medical Field

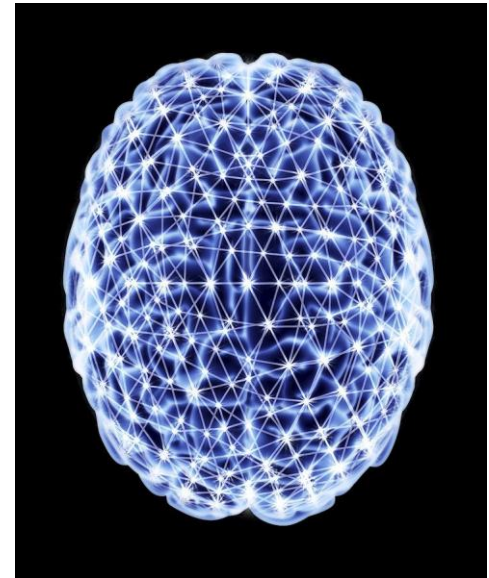


Outline

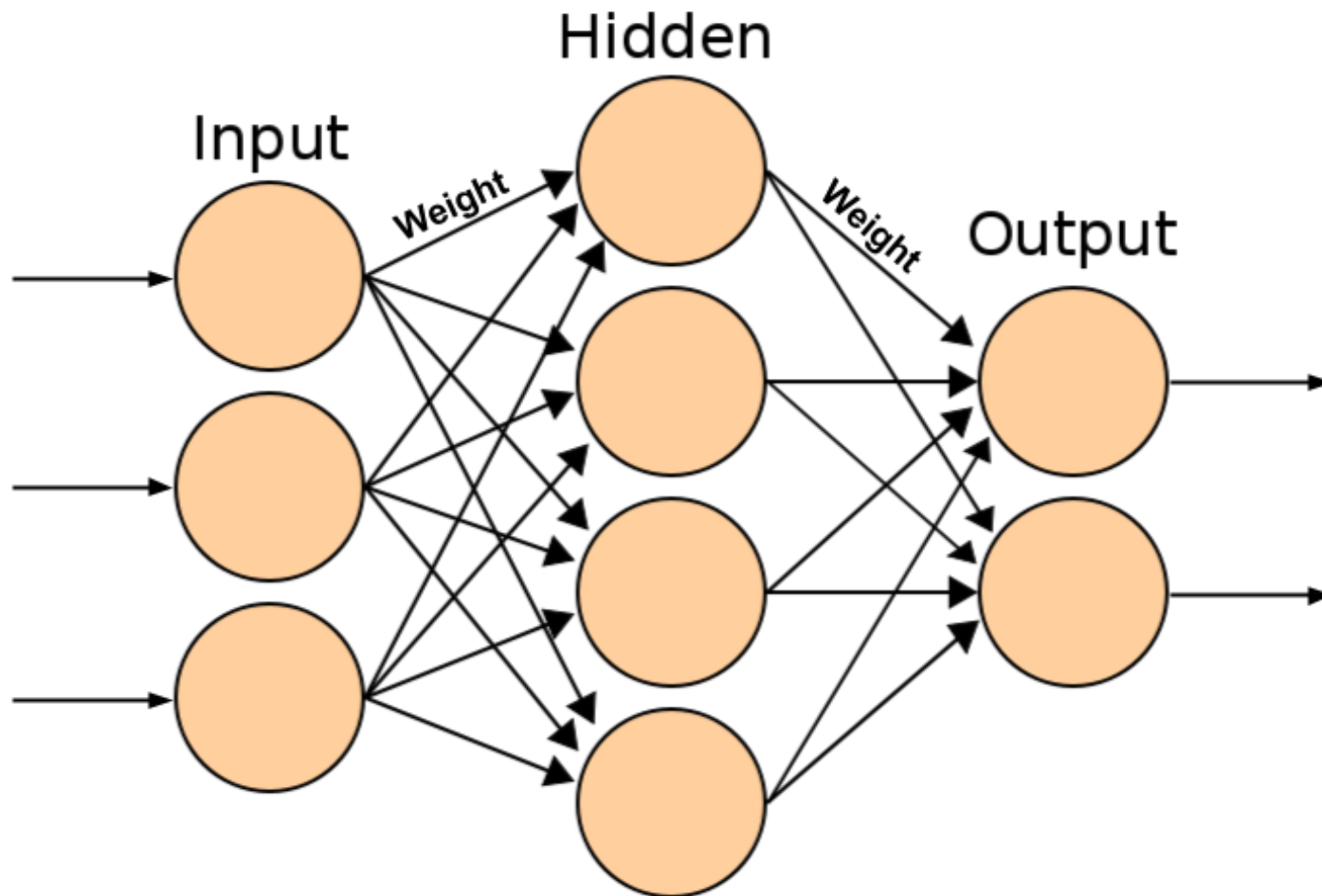
1. Introduction
 2. Neural Networks
 3. Deep Neural Networks
 4. Computer Vision
 5. Navigation
 6. Conclusion
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Inspiration

- ▶ 100 Billion Neurons
- ▶ Trillions of connections
- ▶ Always changing/learning

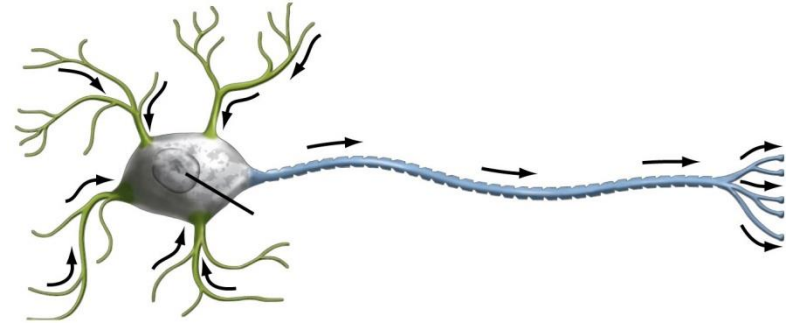


Basic Neural Network Structure



Artificial Neurons

Biological Neuron

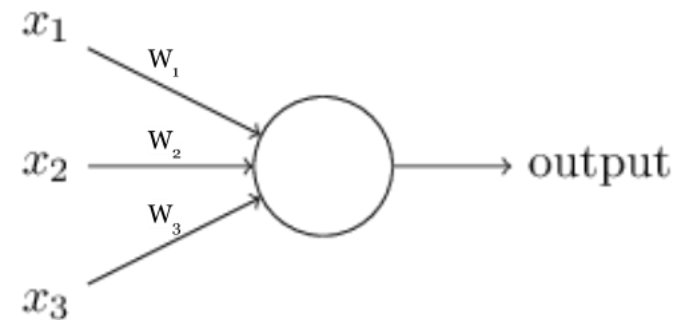


Artificial Neuron

$$(x_1w_1) + (x_2w_2) + (x_3w_3) = \text{Total Input}$$

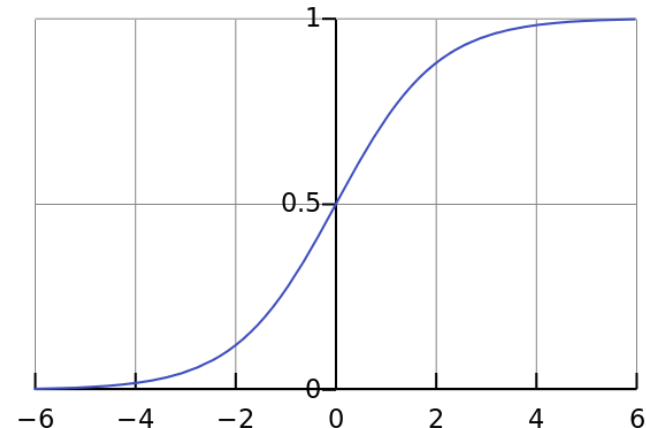
Output = 0 if Total Input \leq Threshold Value

Output = 1 if Total Input $>$ Threshold Value



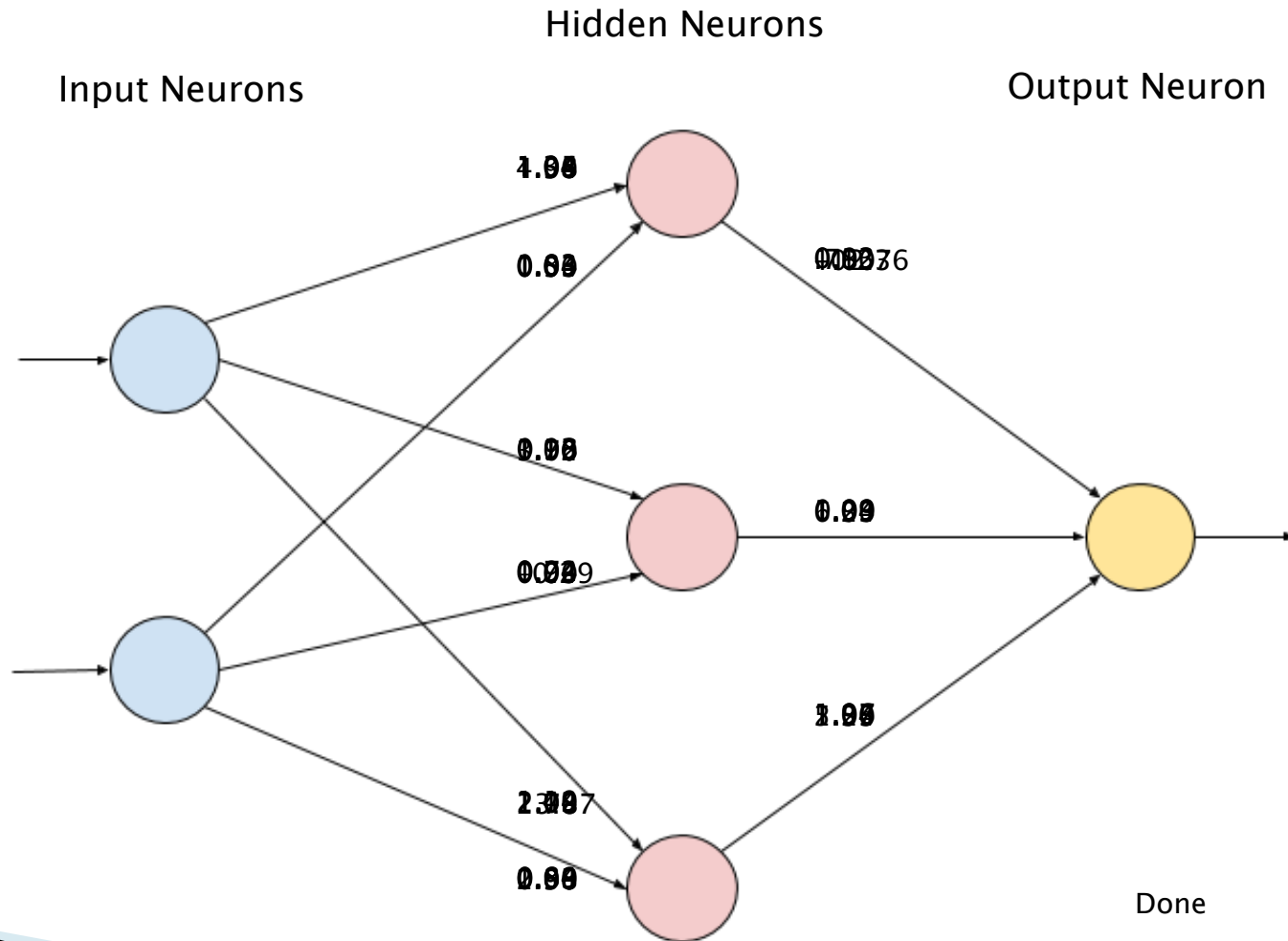
Sigmoid Function

$$\text{Output} = \frac{1}{1 + e^{-\text{Total Input}}}$$

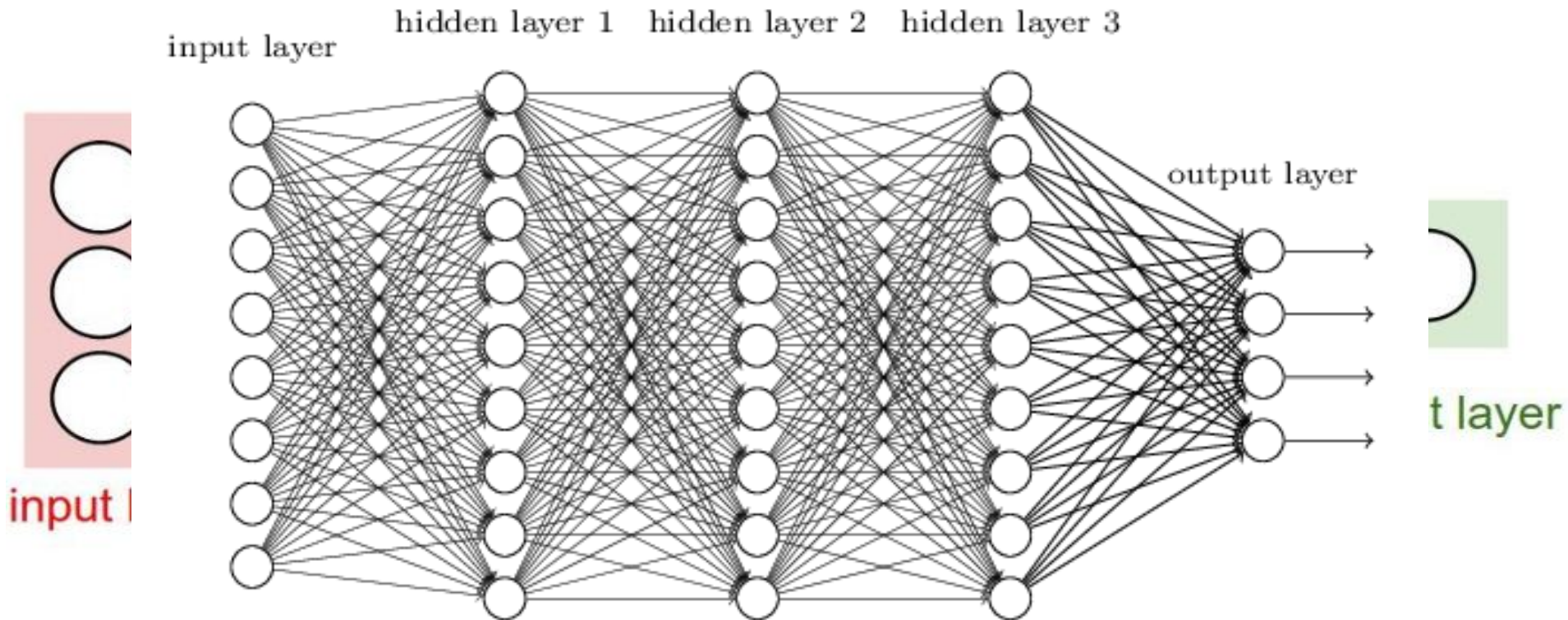


Training

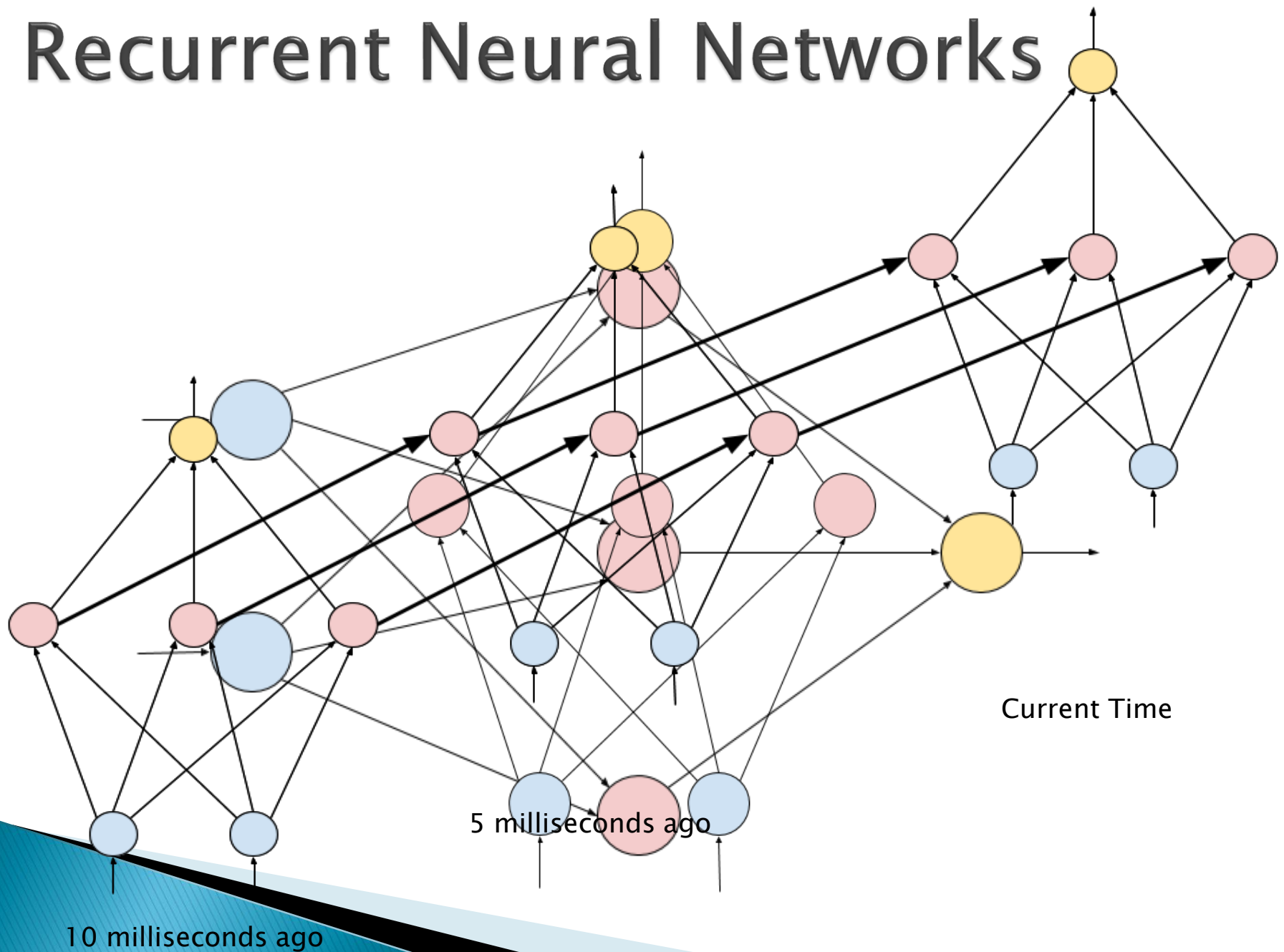
$$\Delta \text{weight}_i = \frac{\partial \text{Error}}{\partial \text{weight}_i} * \text{learning rate}$$



Deep Neural Networks

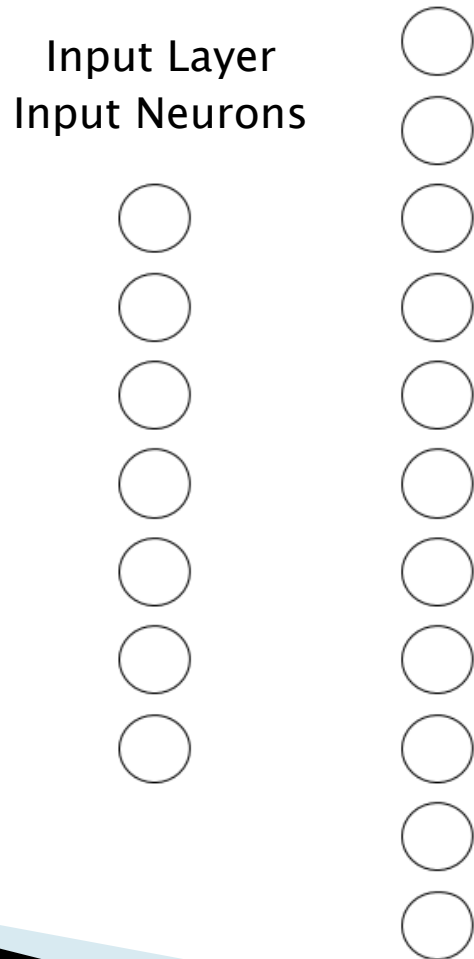


Recurrent Neural Networks



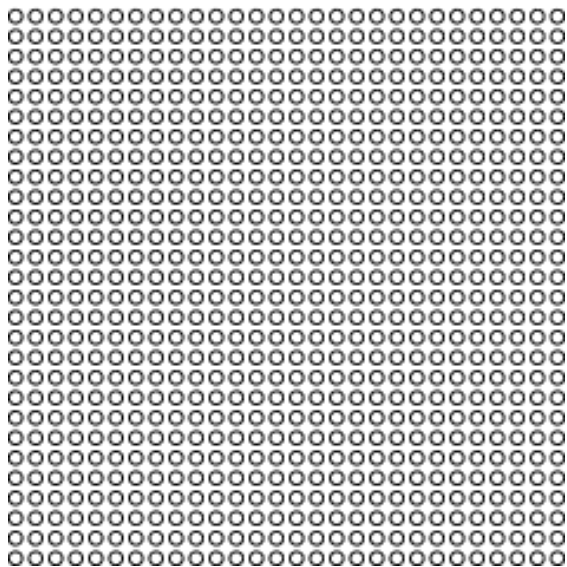
Convolutional Neural Networks

First Hidden Layer
Hidden Neurons

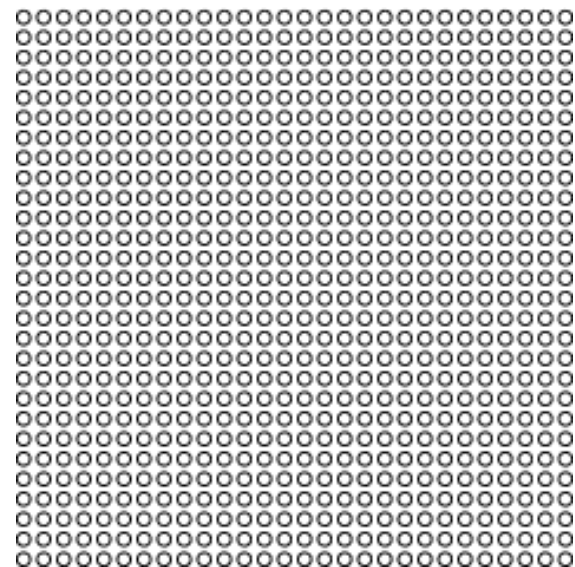


Convolutional Neural Networks

Input Layer
Input Neurons

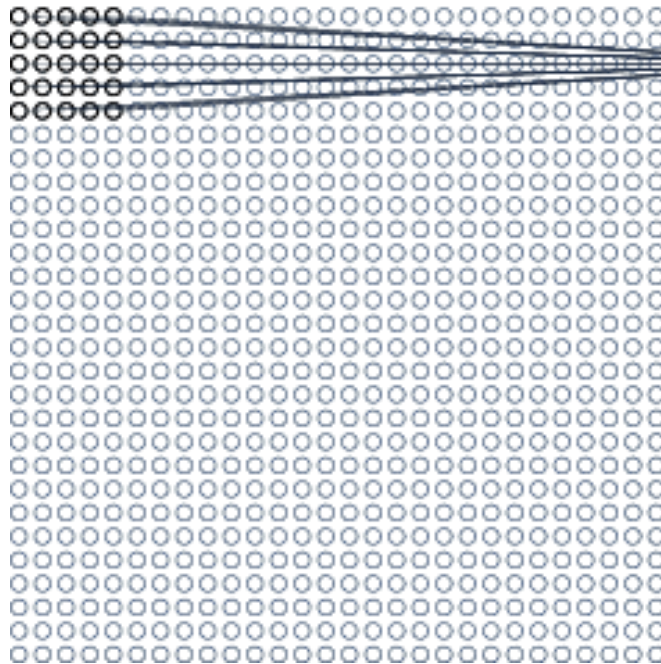


First Hidden Layer
Hidden Neurons

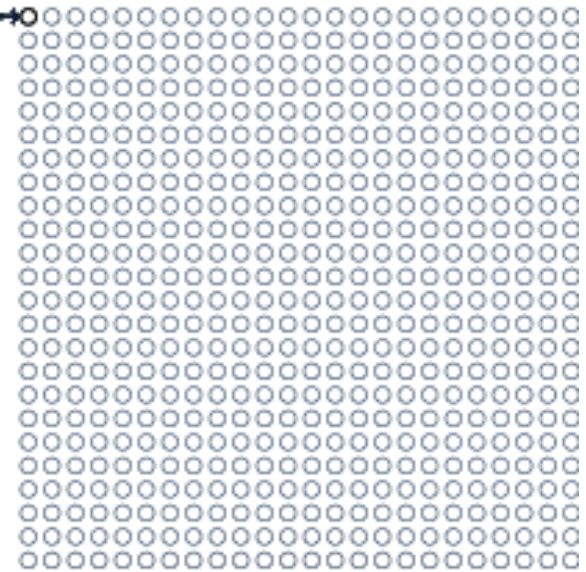


Convolutional Neural Networks

Input Layer
Input Neurons



First Hidden Layer
Hidden Neurons

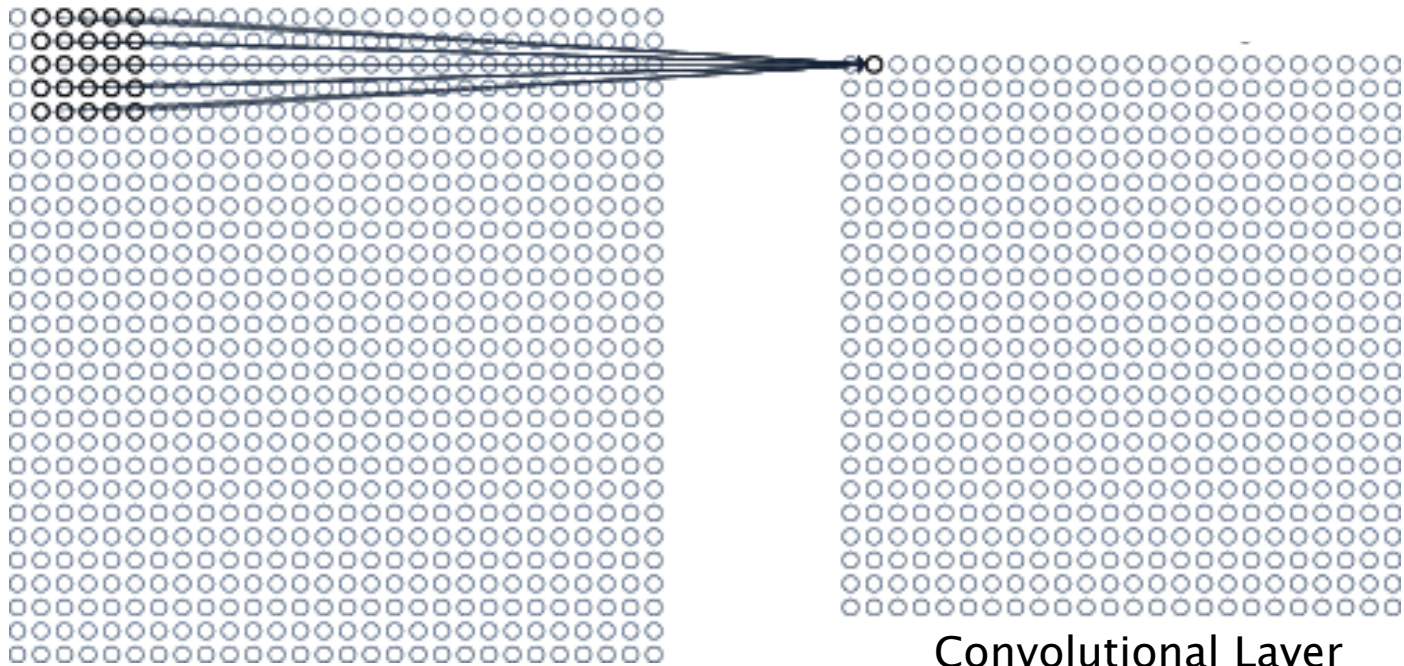


Convolutional Layer

Convolutional Neural Networks

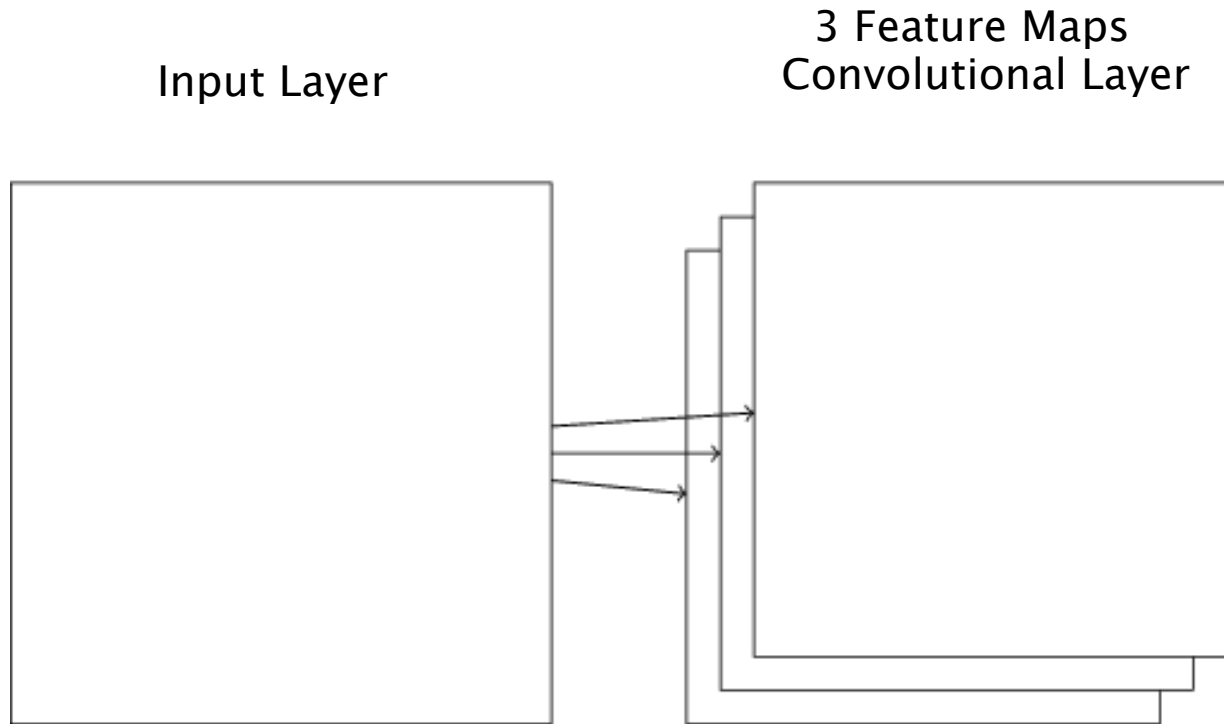
Input Layer
Input Neurons

First Hidden Layer
Hidden Neurons

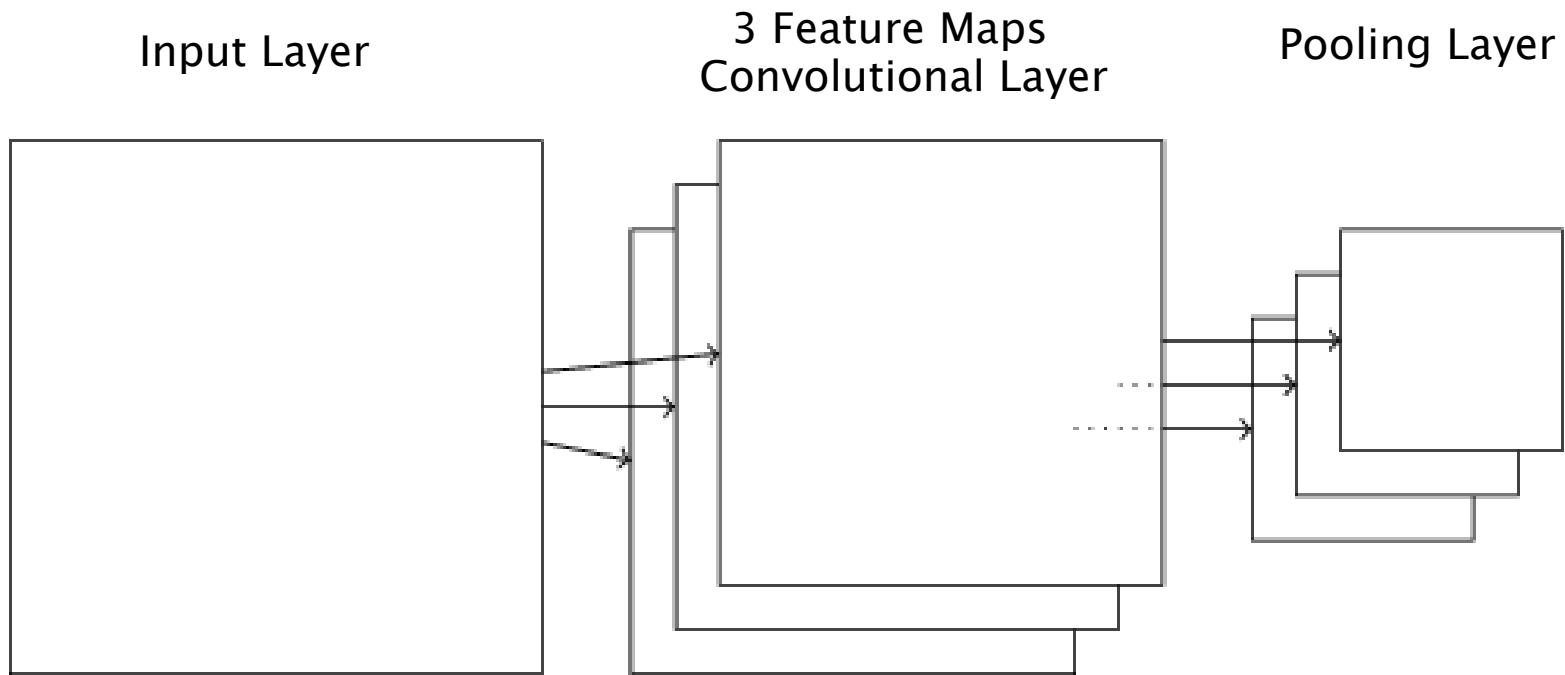


Convolutional Layer

Convolutional Neural Networks



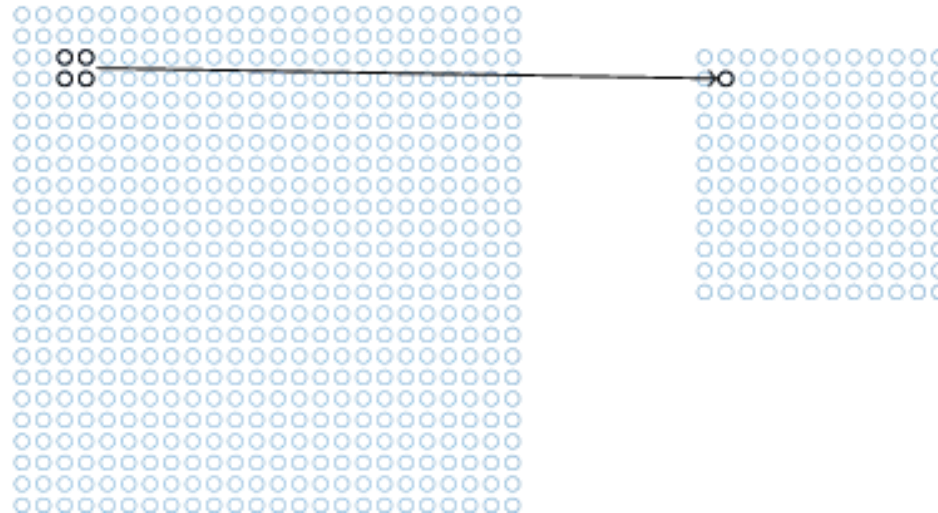
Pooling



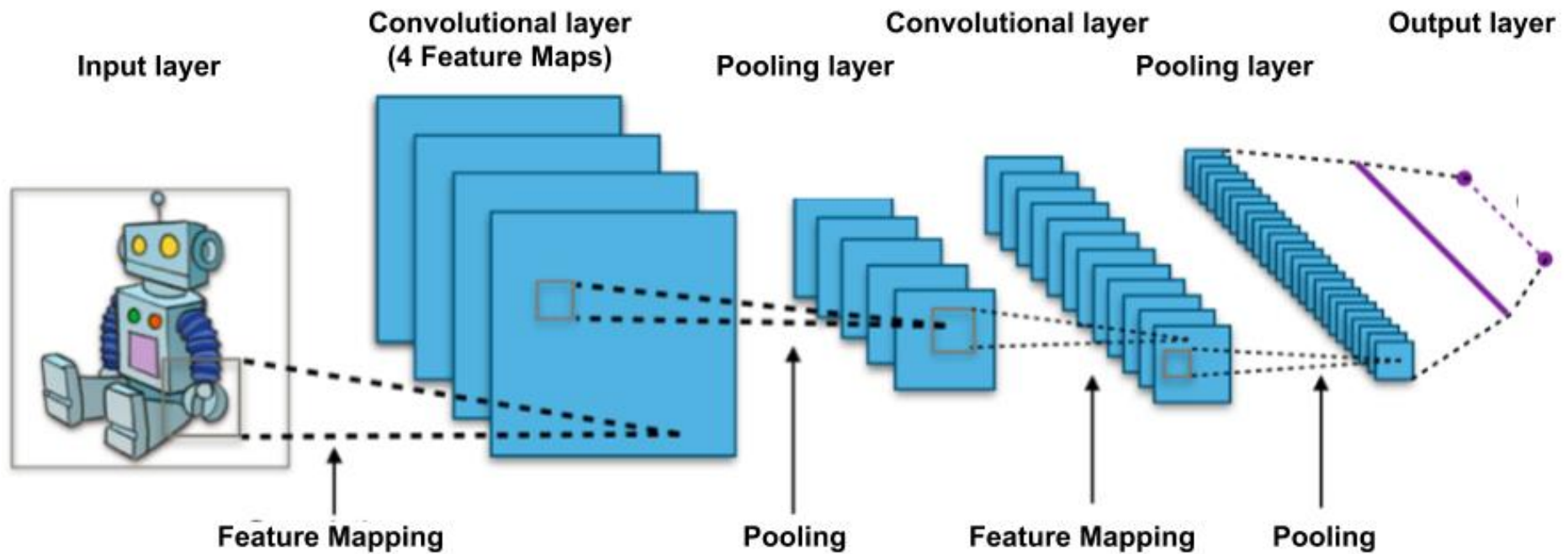
Pooling

Convolutional Layer

Pooling Layer

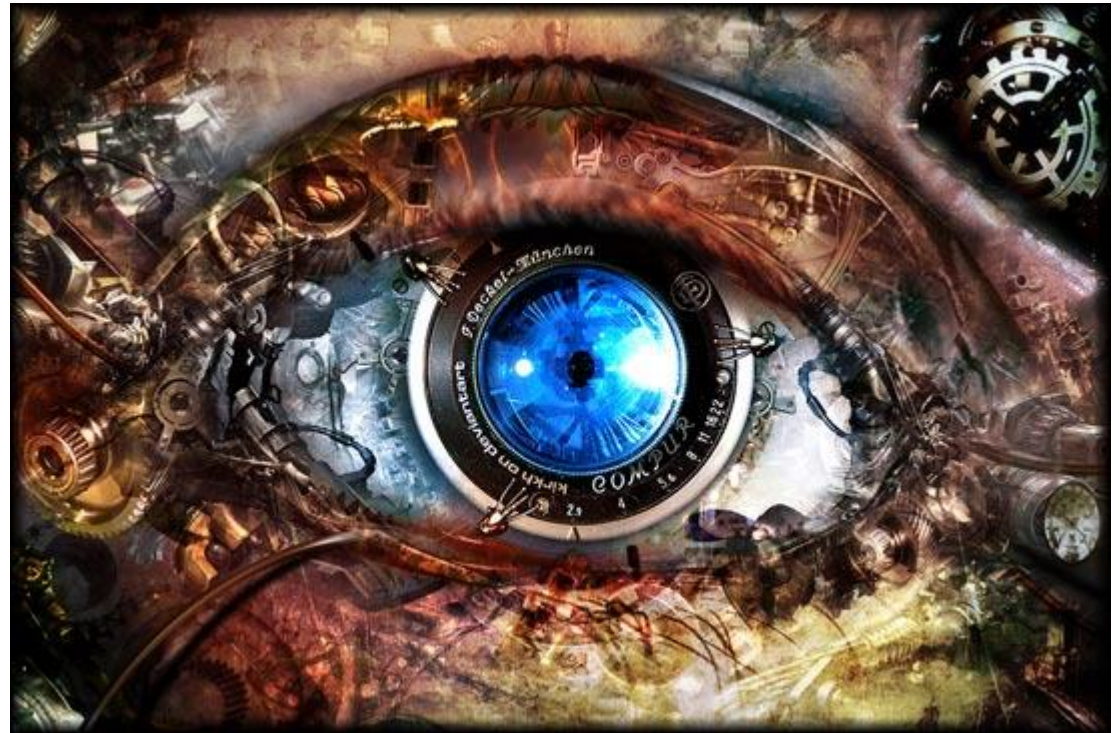


Convolutional Neural Networks



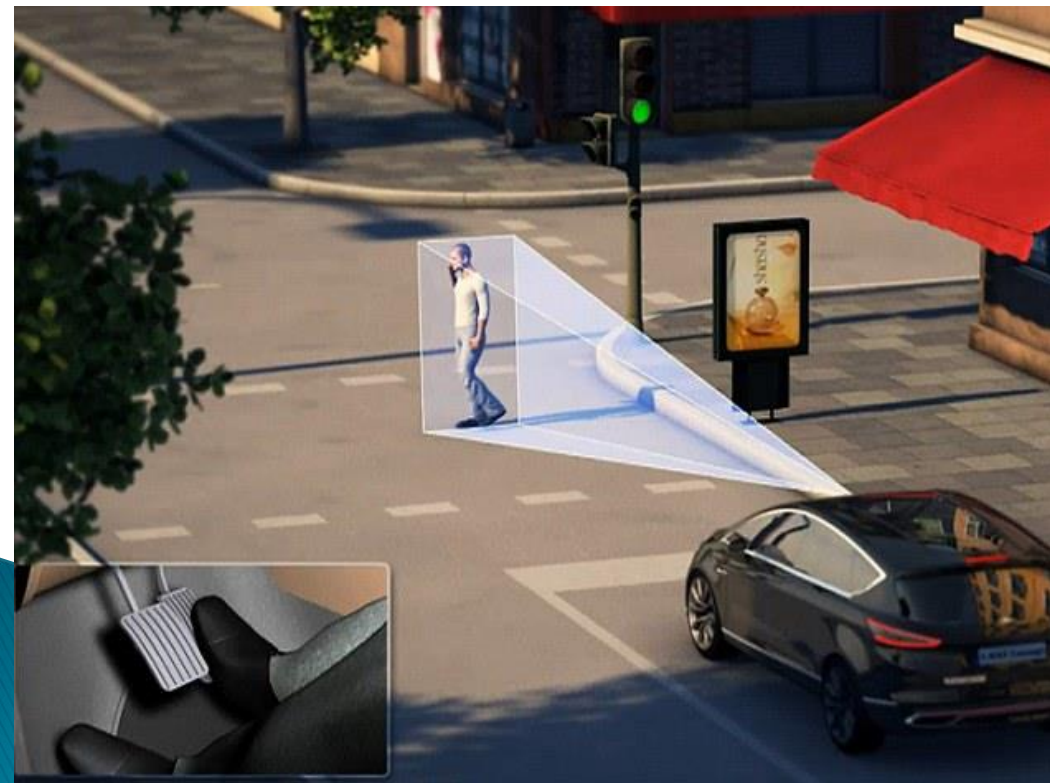
Computer Vision

- ▶ Aware of surroundings
- ▶ Detect Objects Continuously
- ▶ RADAR
- ▶ SONAR
- ▶ IMU
- ▶ Infrared
- ▶ GPS
- ▶ LIDAR
- ▶ Video

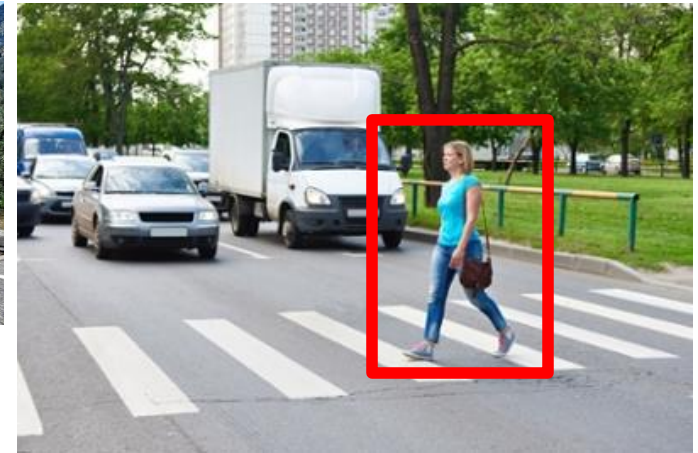


Car Cameras

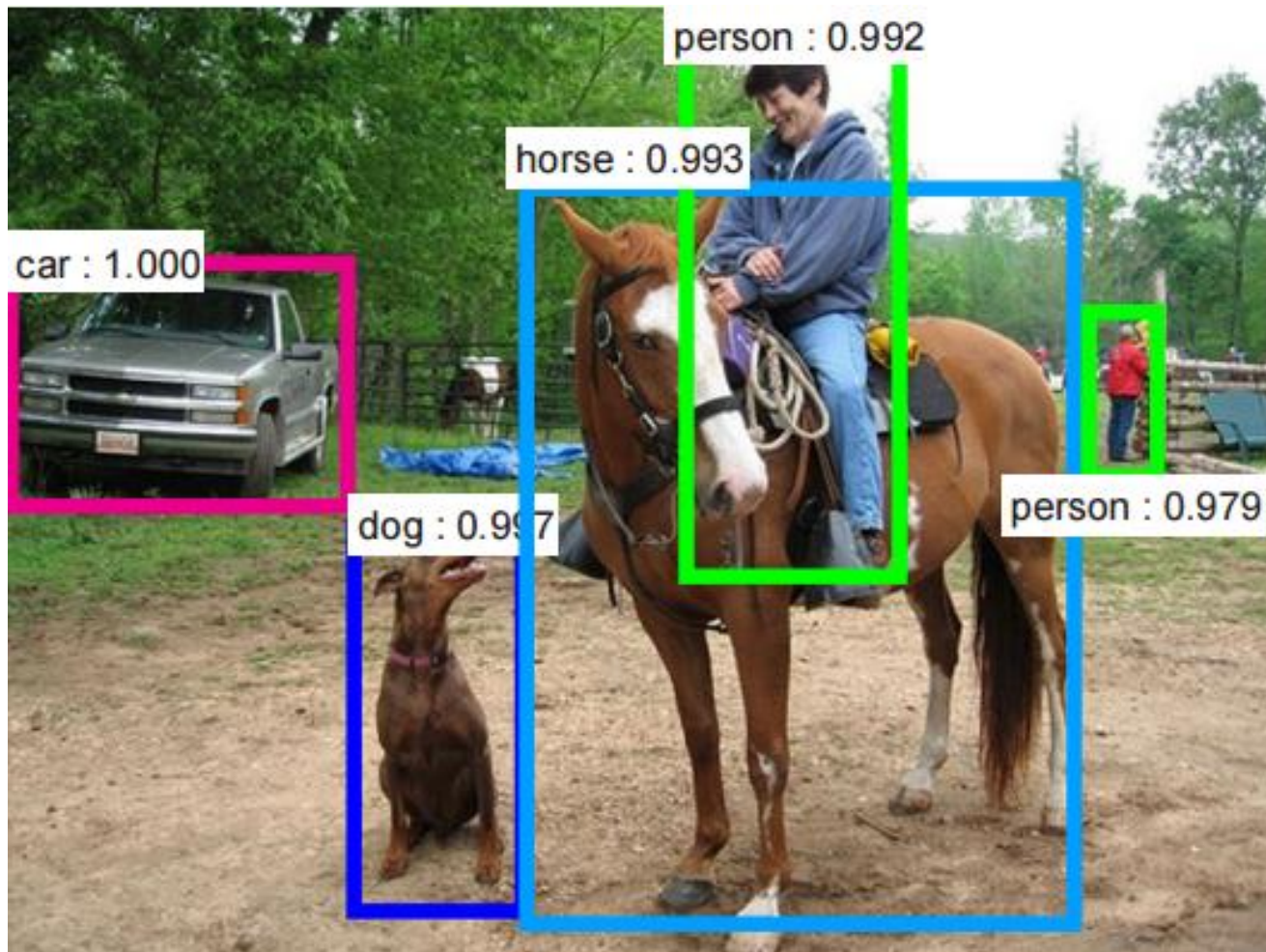
- ▶ Placed in pairs
- ▶ Detect Objects
- ▶ Read road signs and traffic lights



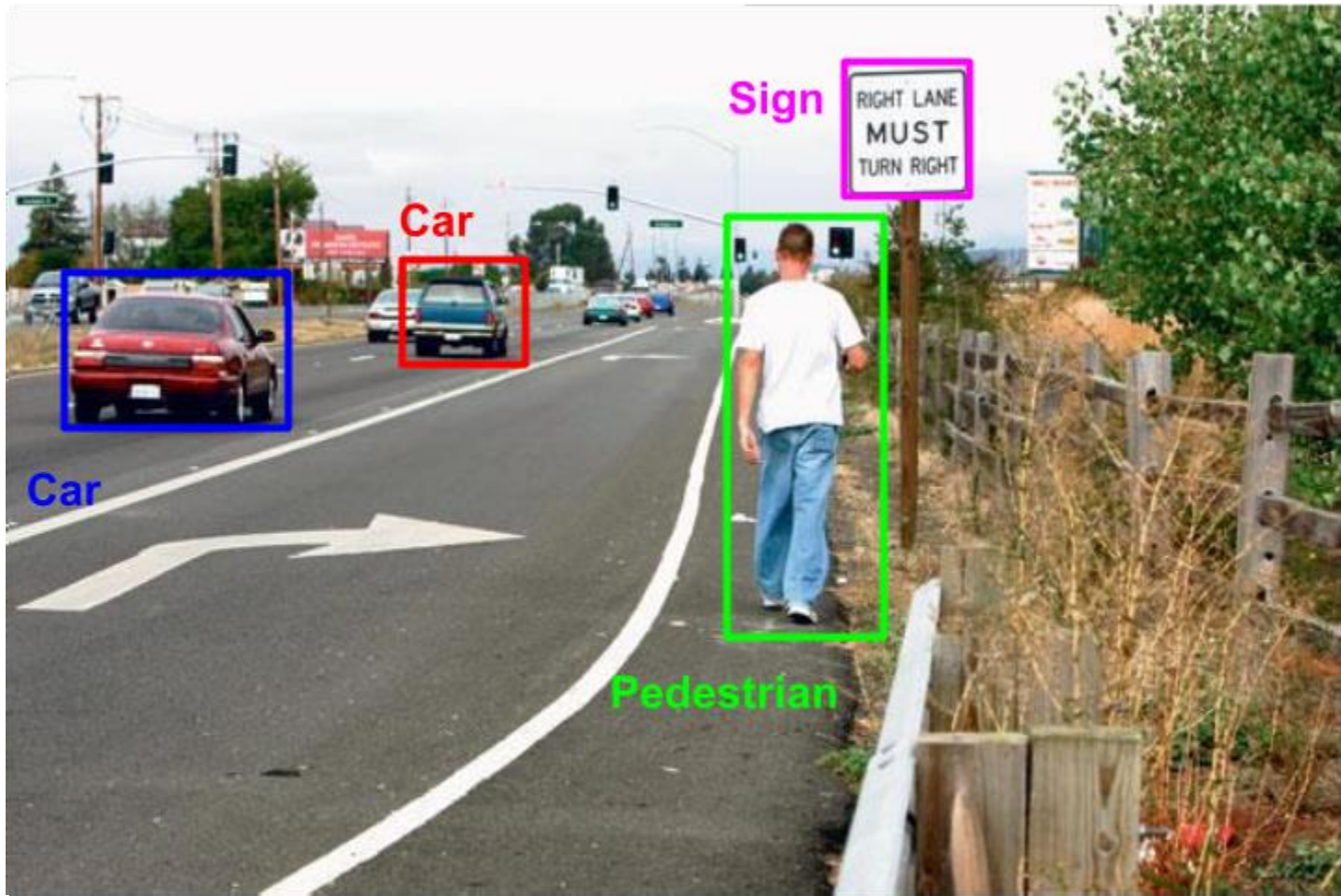
Object Detection



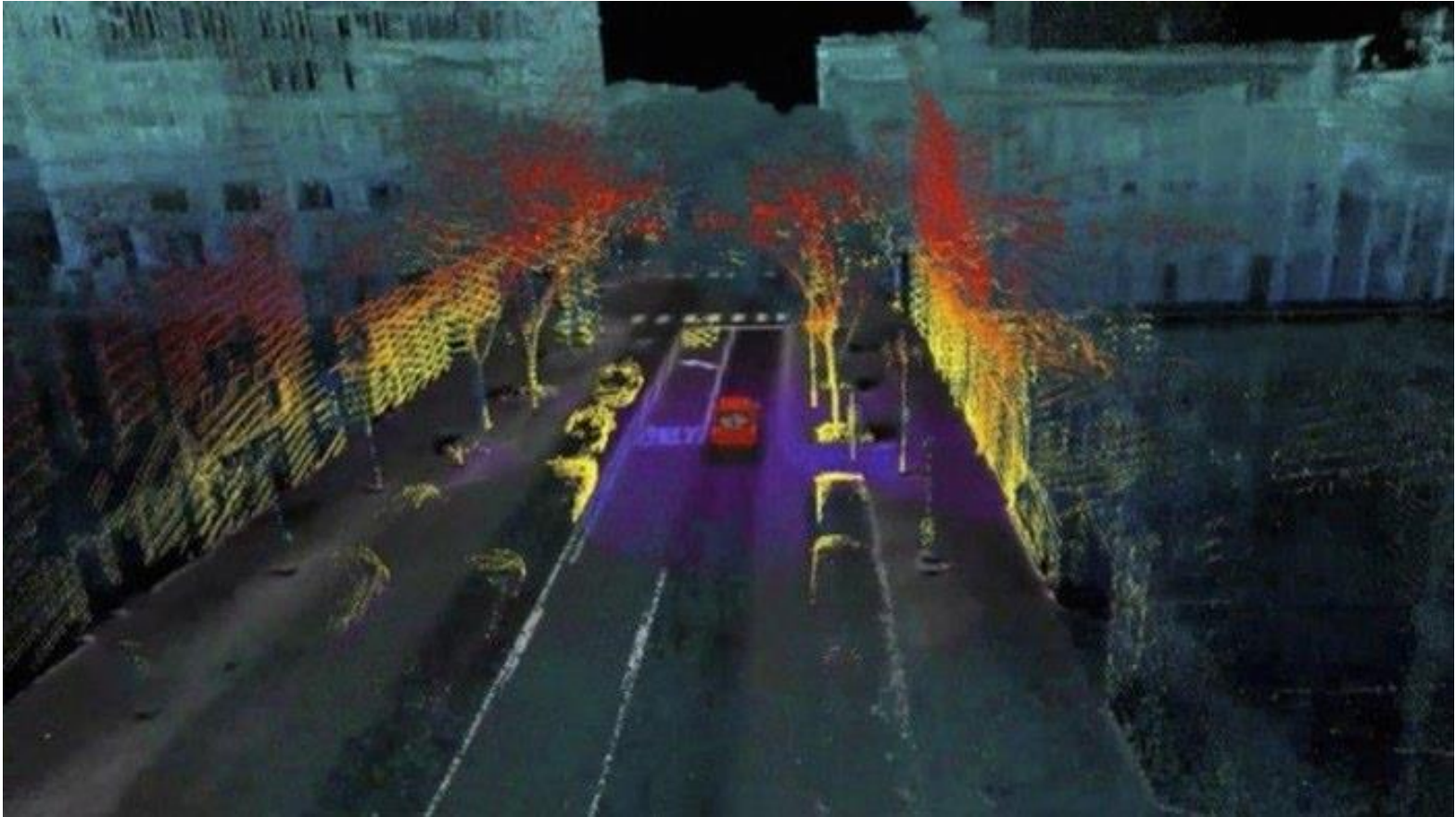
Bounding Boxes



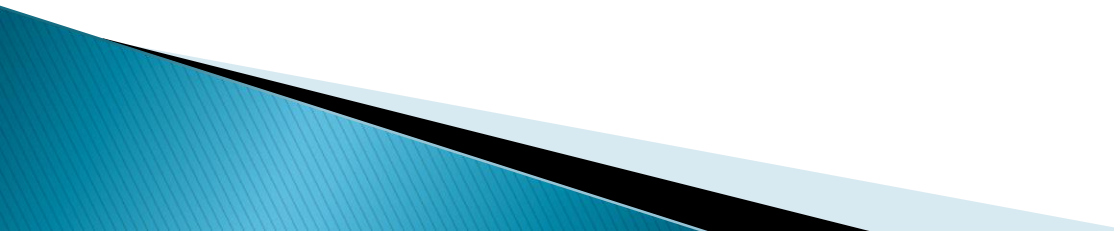
Bounding Boxes



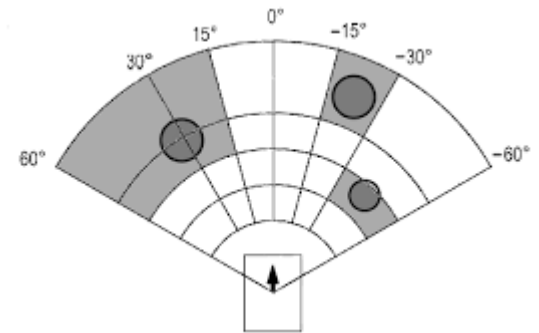
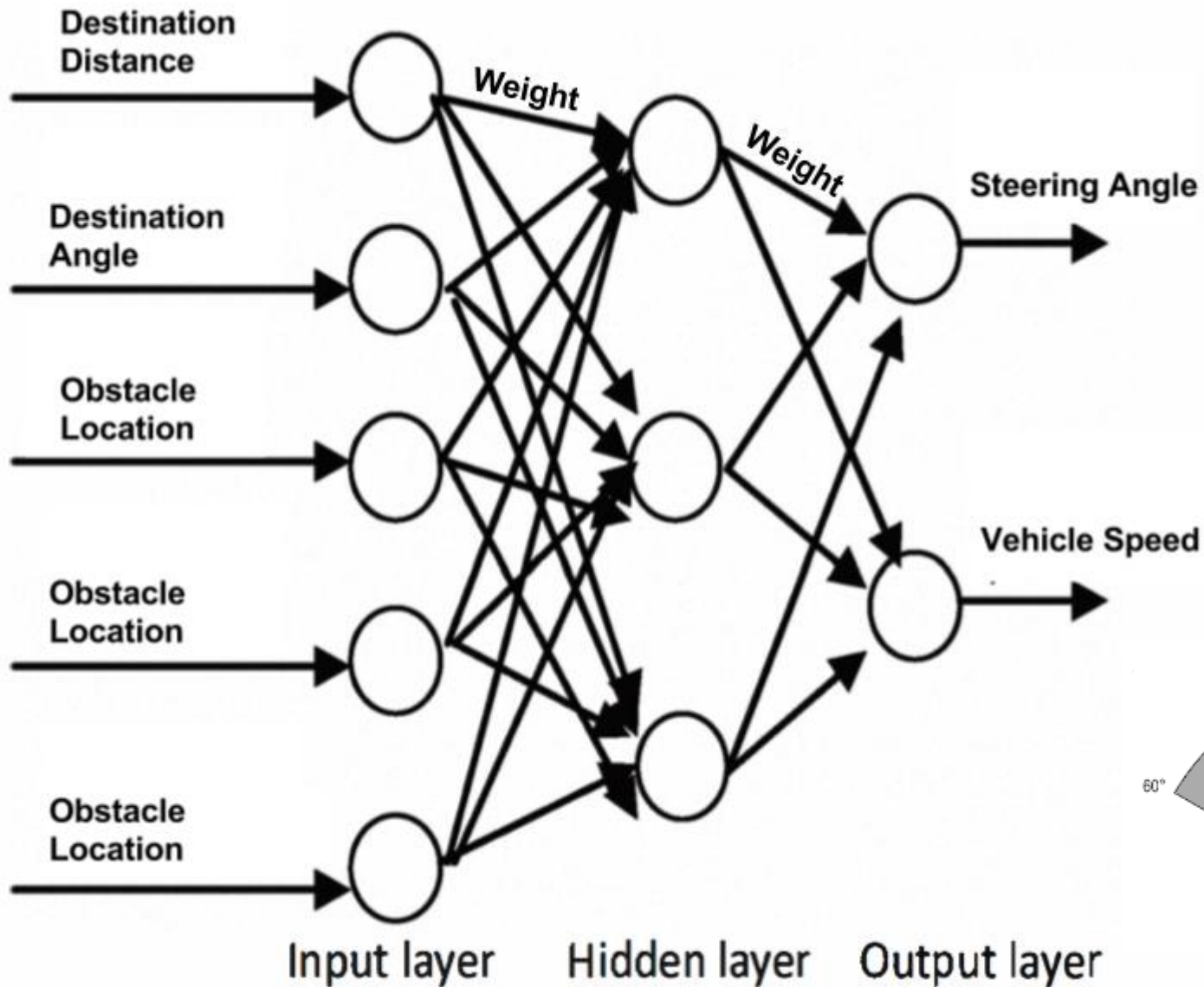
LIDAR



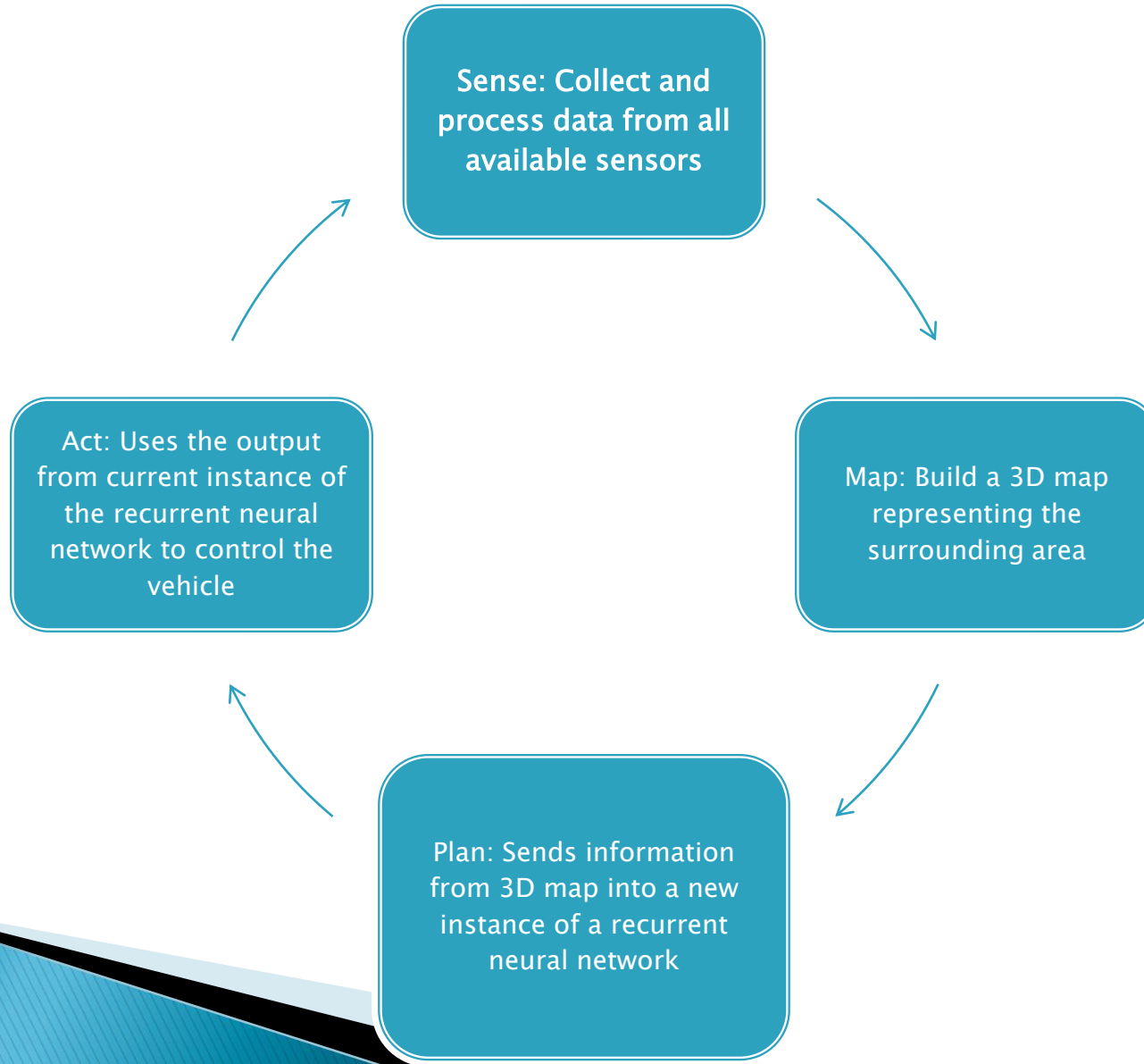
Obstacle Avoidance

- ▶ Neural networks are effective at navigating and avoiding obstacles
 - ▶ Inputs to the network include the vehicle destination and obstacles to avoid
 - ▶ The network outputs an angle to steer and a speed
 - ▶ The network learns by observation
- 

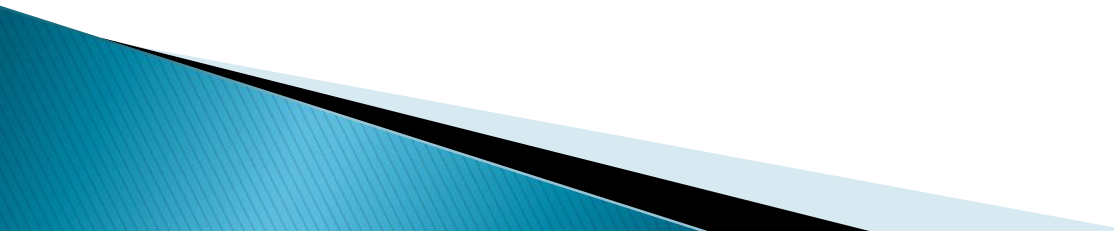
Obstacle Avoidance



Self-Driving Car Loop



Self-Driving Cars

- ▶ Generate multiple paths
 - ▶ Equipped with powerful computers on-board
 - ▶ Google has created a simulator for training
 - ▶ Thousands of scenarios in hours rather than decades
 - ▶ Can react safely in dangerous situations
 - ▶ Always learning
- 



Conclusion

- ▶ Convolutional neural networks detect locations of surrounding objects
- ▶ Recurrent neural networks process the world and give instructions to control vehicles



RENAULT



Questions?