



Deep Learning's Application in Driverless Cars | Gan Luan Wenlong Feng

Outline

Introduction

Sensor and Autonomous
Driving Tasks

Object Detection and
Semantic Segmentation

Limitation

What is a
driverless car?

From Wiki:

A **driverless car**, also known as a **robot car**, **autonomous car**, or **self-driving** car, is a vehicle that is capable of sensing its environment and moving with little or no human input.



SAE J3016™ LEVELS OF DRIVING AUTOMATION

	SAE LEVEL 0	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
What does the human in the driver's seat have to do?	You <u>are</u> driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering			You <u>are not</u> driving when these automated driving features are engaged – even if you are seated in “the driver's seat”		
	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
What do these features do?	These are driver support features			These are automated driving features		
	These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/acceleration support to the driver	These features provide steering AND brake/acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example Features	<ul style="list-style-type: none">• automatic emergency braking• blind spot warning• lane departure warning	<ul style="list-style-type: none">• lane centering OR• adaptive cruise control	<ul style="list-style-type: none">• lane centering AND• adaptive cruise control at the same time	<ul style="list-style-type: none">• traffic jam chauffeur	<ul style="list-style-type: none">• local driverless taxi• pedals/steering wheel may or may not be installed	<ul style="list-style-type: none">• same as level 4, but feature can drive everywhere in all conditions

Pros and Cons

Pros:

- Safety
- Welfare
- Reduced Traffic Congestions
- Parking Space

Cons:

- Unemployment
- Cost
- Safety Concern
- Privacy Concern

Current Status

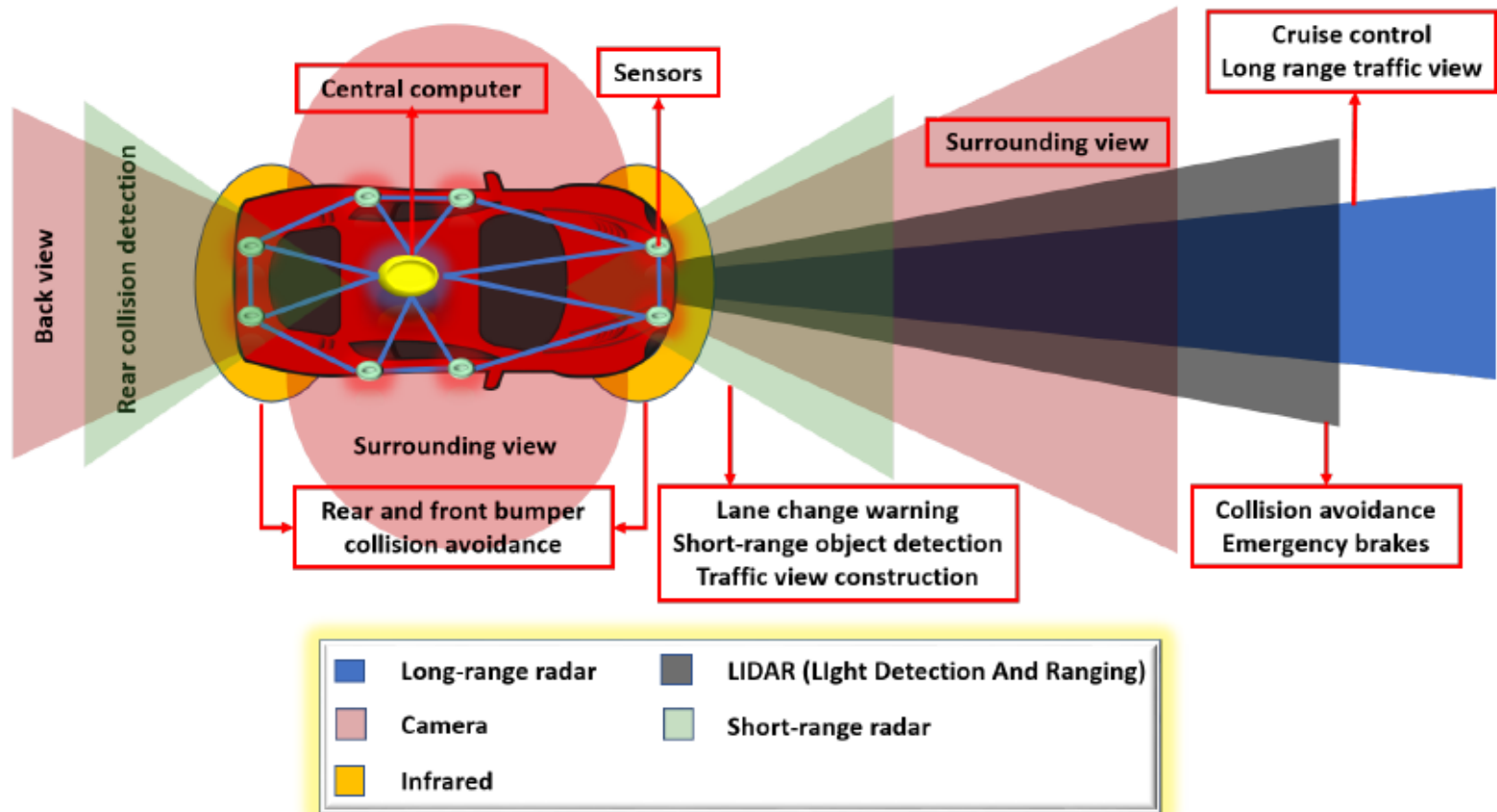
Waymo: provide auto driving rides/
8 million miles autonomously

Uber: 3 million miles autonomously

Tesla: 1 billion miles with Autopilot

Audi: Audi A8 first L3 auto driving

Sensors on an Autonomous Car



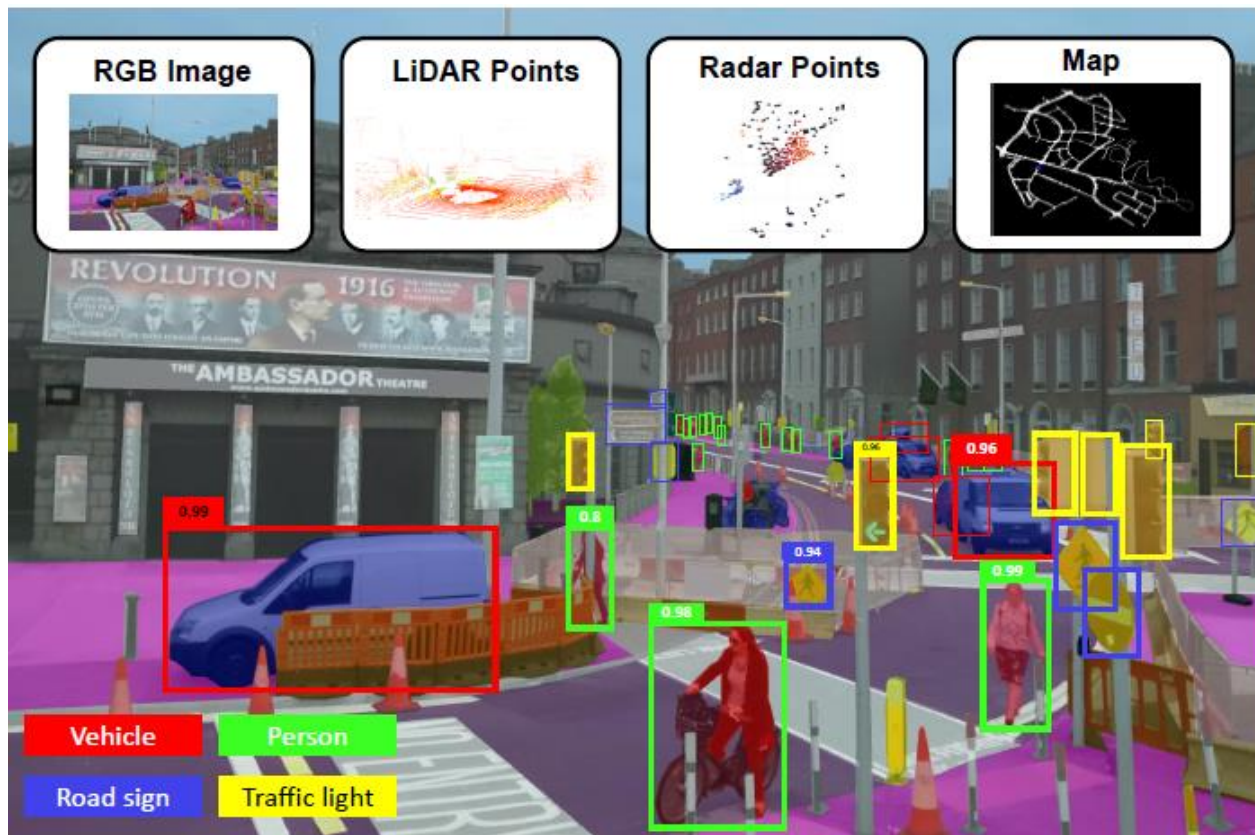
Task in Autonomous Driving

Situational and environmental
awareness

Navigation and path planning

Maneuver control

Autonomous car perception is critical

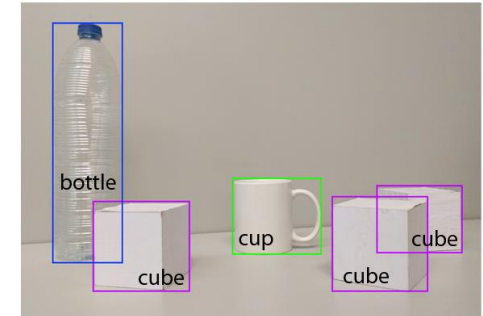


Two fundamental problems in perception

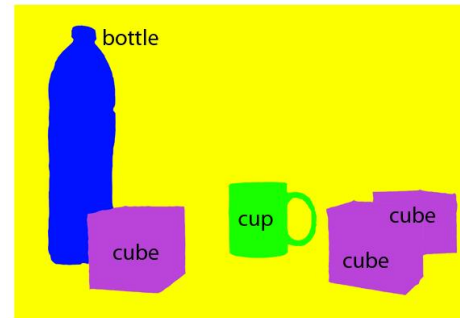
- Object detection
To recognize and Localize multiple objects in a scene.
- Semantic Segmentation
To partition the image into semantic meaningful parts and label each part with prespecified classes



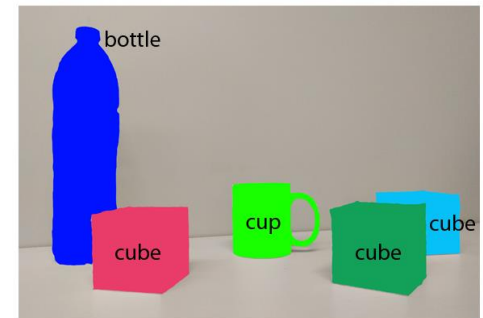
(a) Image classification



(b) Object localization



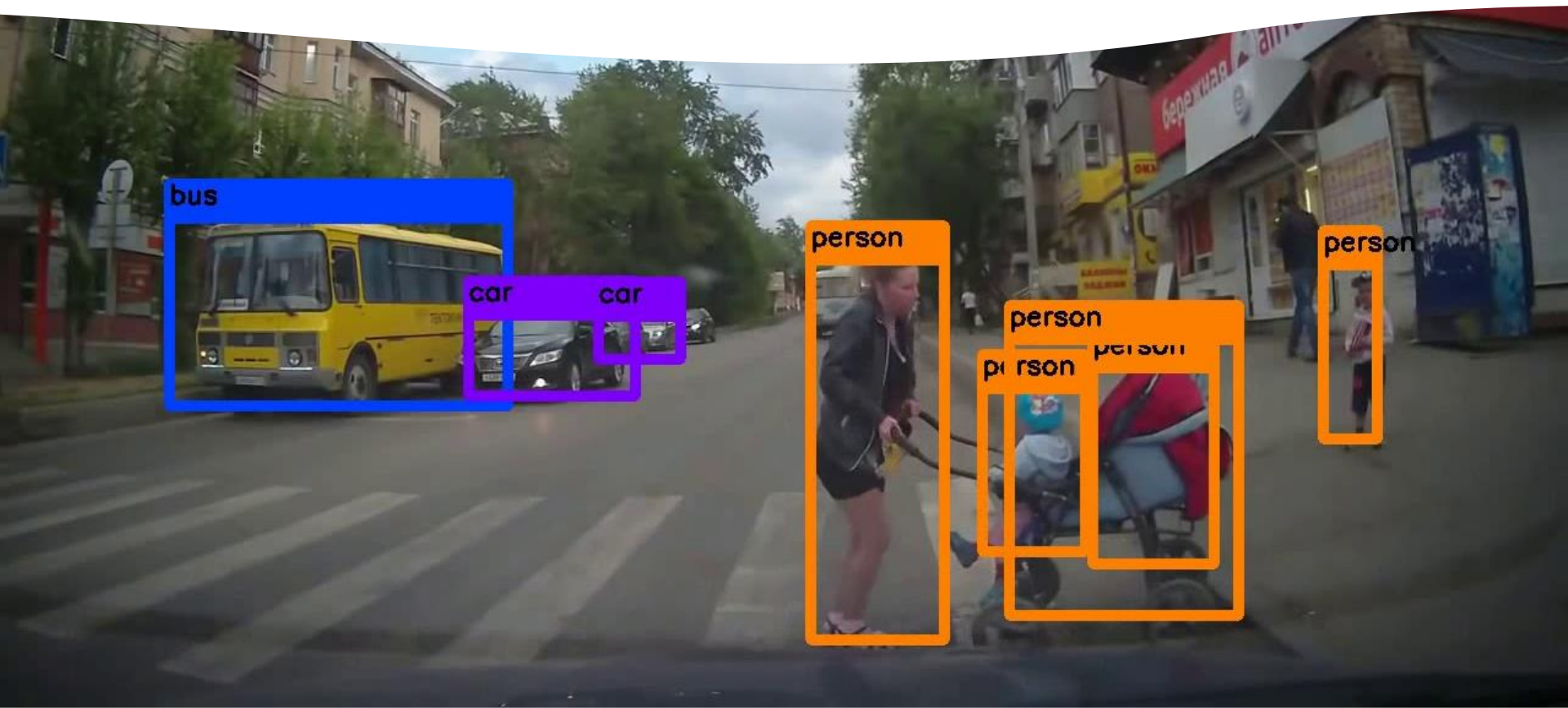
(c) Semantic segmentation



(d) Instance segmentation

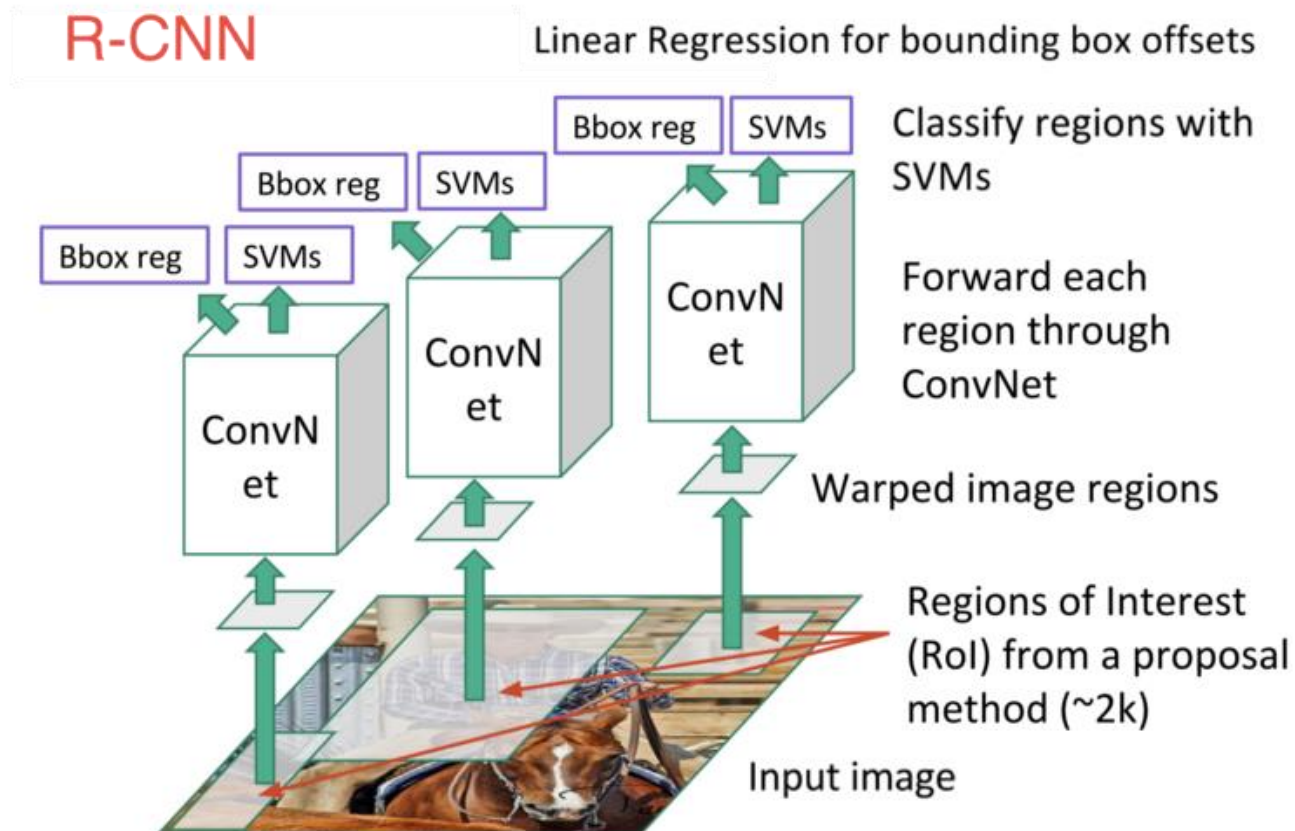
Object detection

- The goal of object detection is to determine whether or not there are any instances of objects from the given categories (such as humans, cars, bicycles) in a scene and to return the spatial location and extent of each object instance
- Objects are usually recognized by estimation classification probability and localized with bounding boxes.



Algorithm for Object Detection

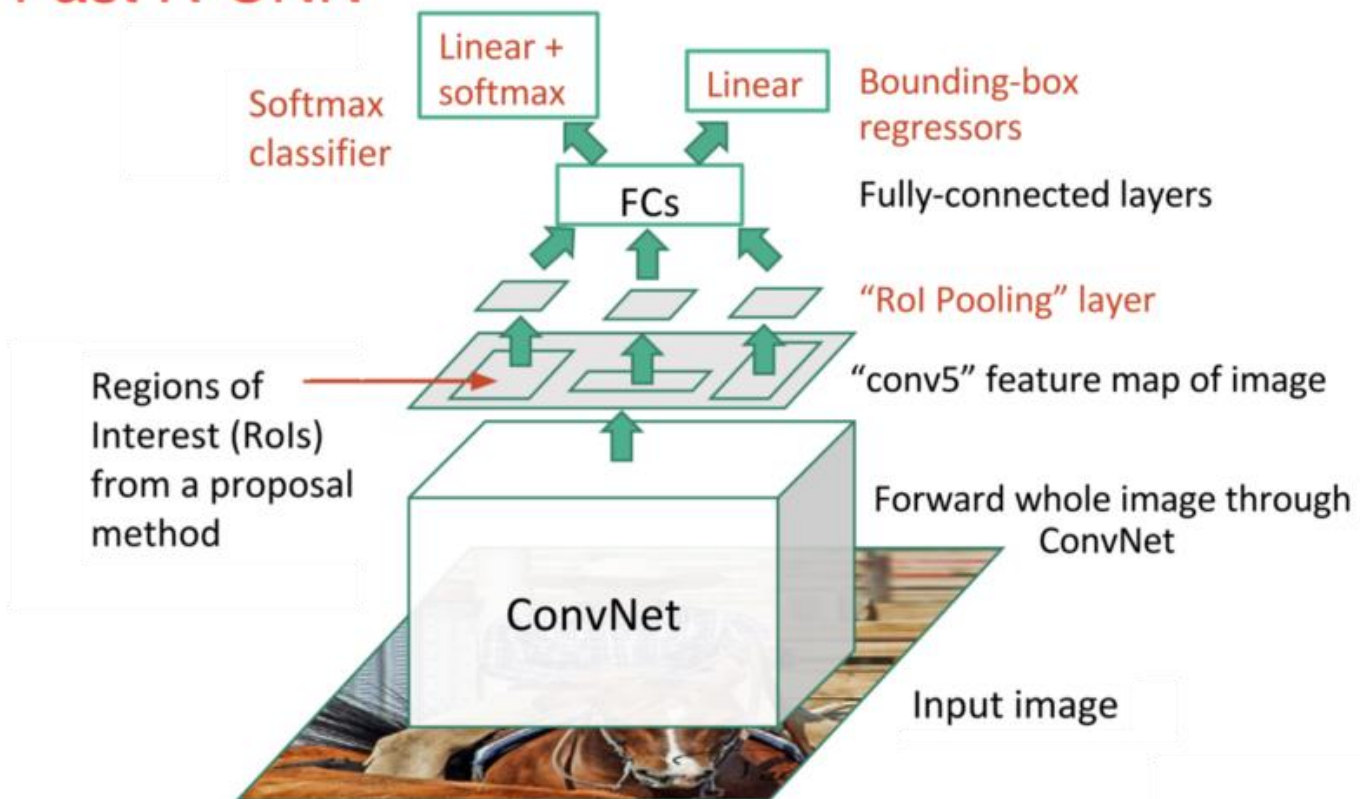
Region-based Convolutional Neural Network (R-CNN)



Algorithm for Object Detection

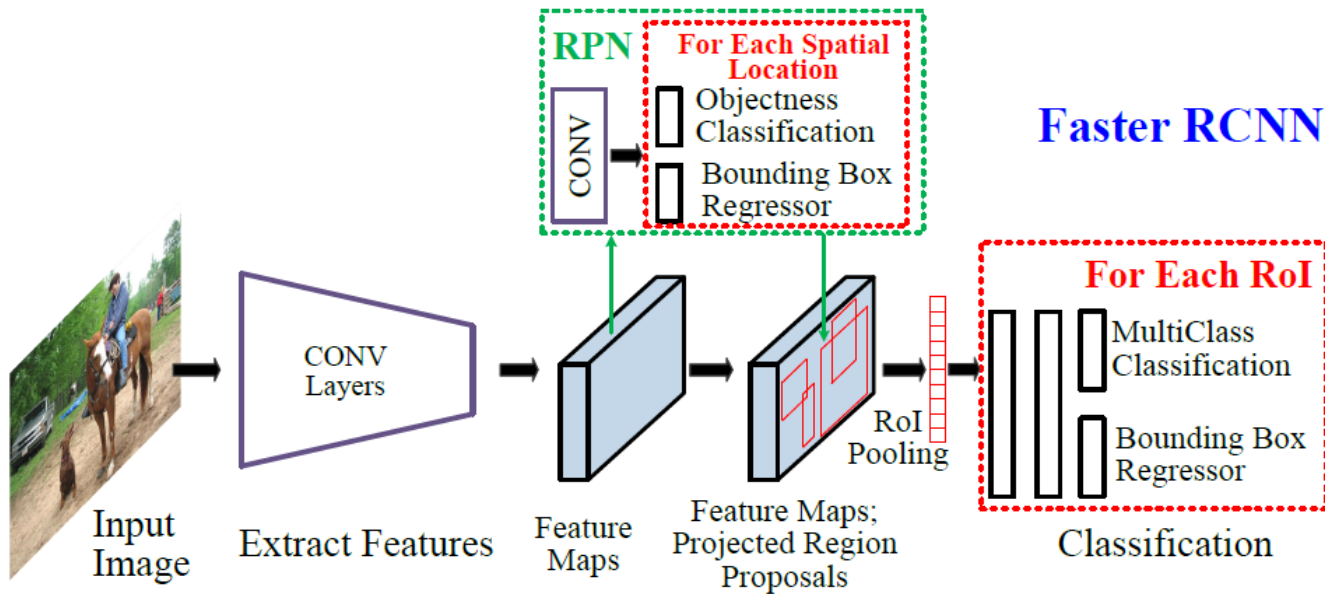
Fast R-CNN

Fast R-CNN



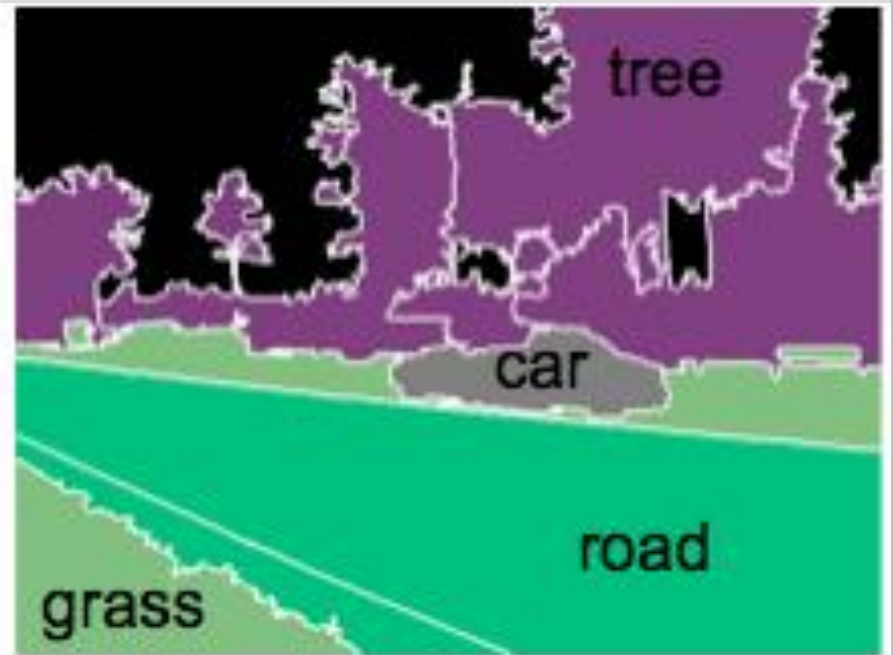
Algorithm for Object Detection

Faster R-CNN



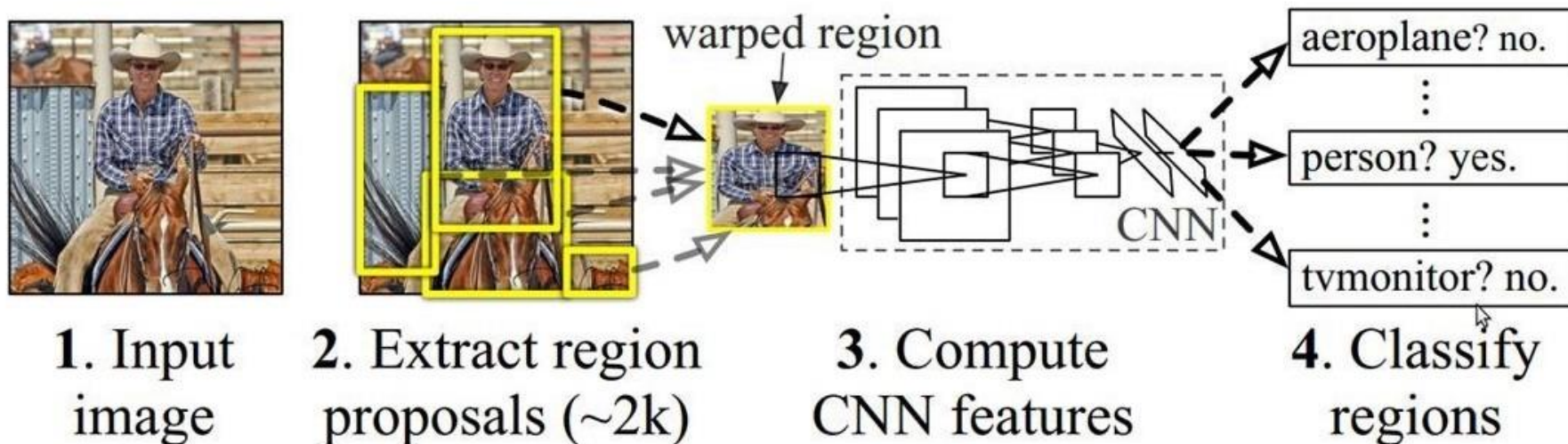
What is Semantic Segmentation?

It attempts to partition the image into semantic meaningful parts and label each parts with prespecified classes.



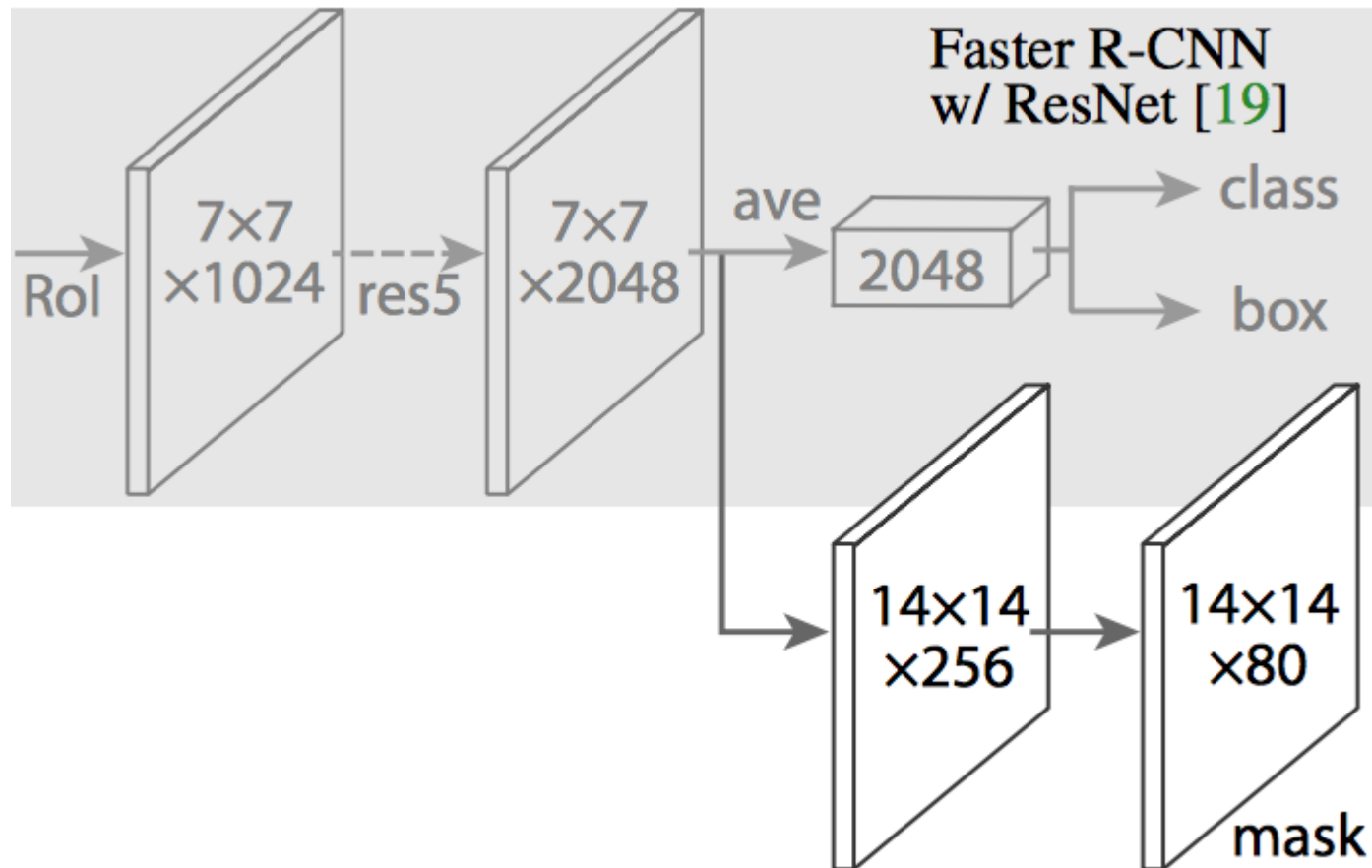
Algorithm for Semantic Segmentation

Region-based Convolutional Neural Networks (R-CNN)



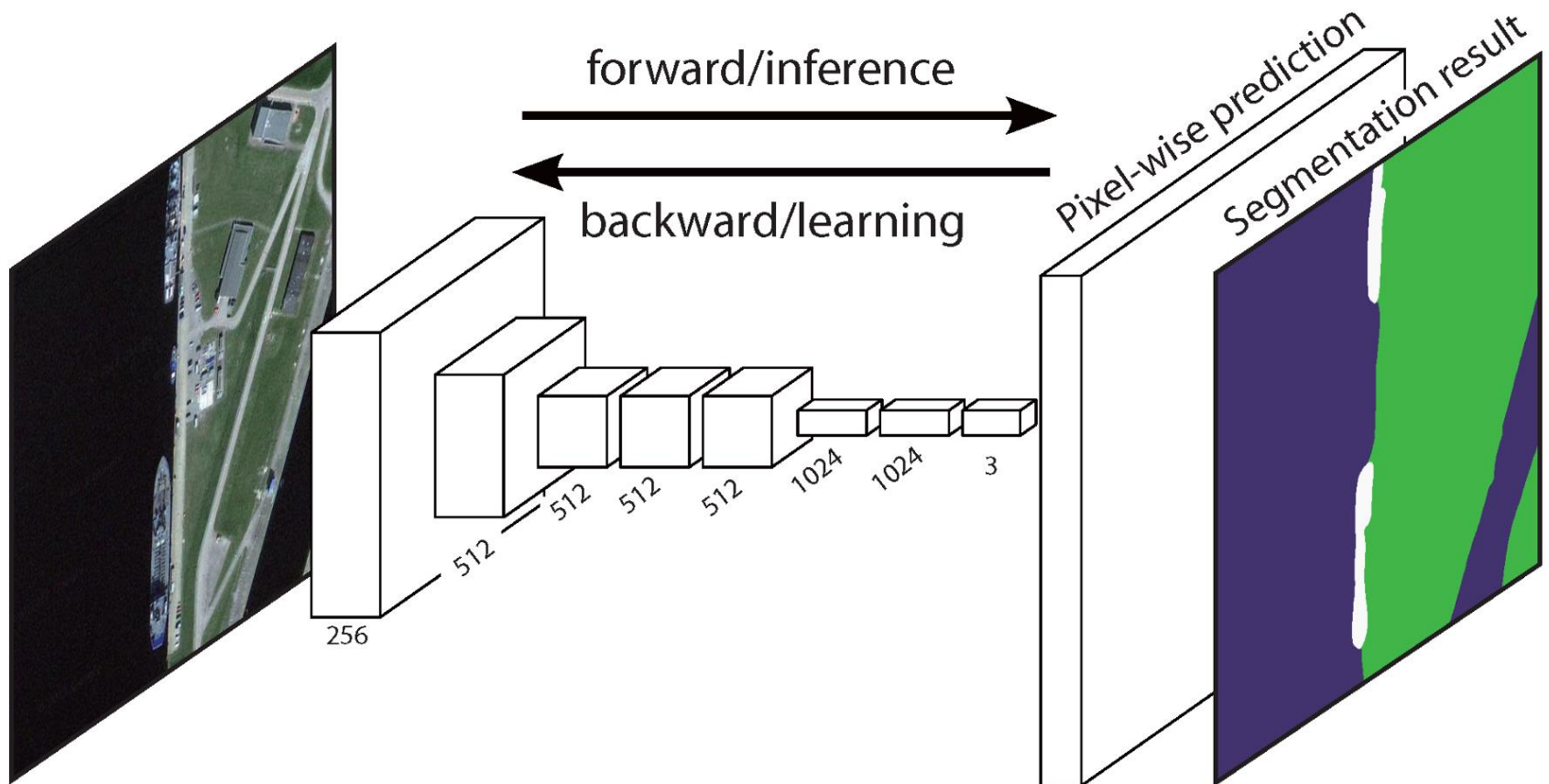
Algorithm for Semantic Segmentation

Mask R-CNN

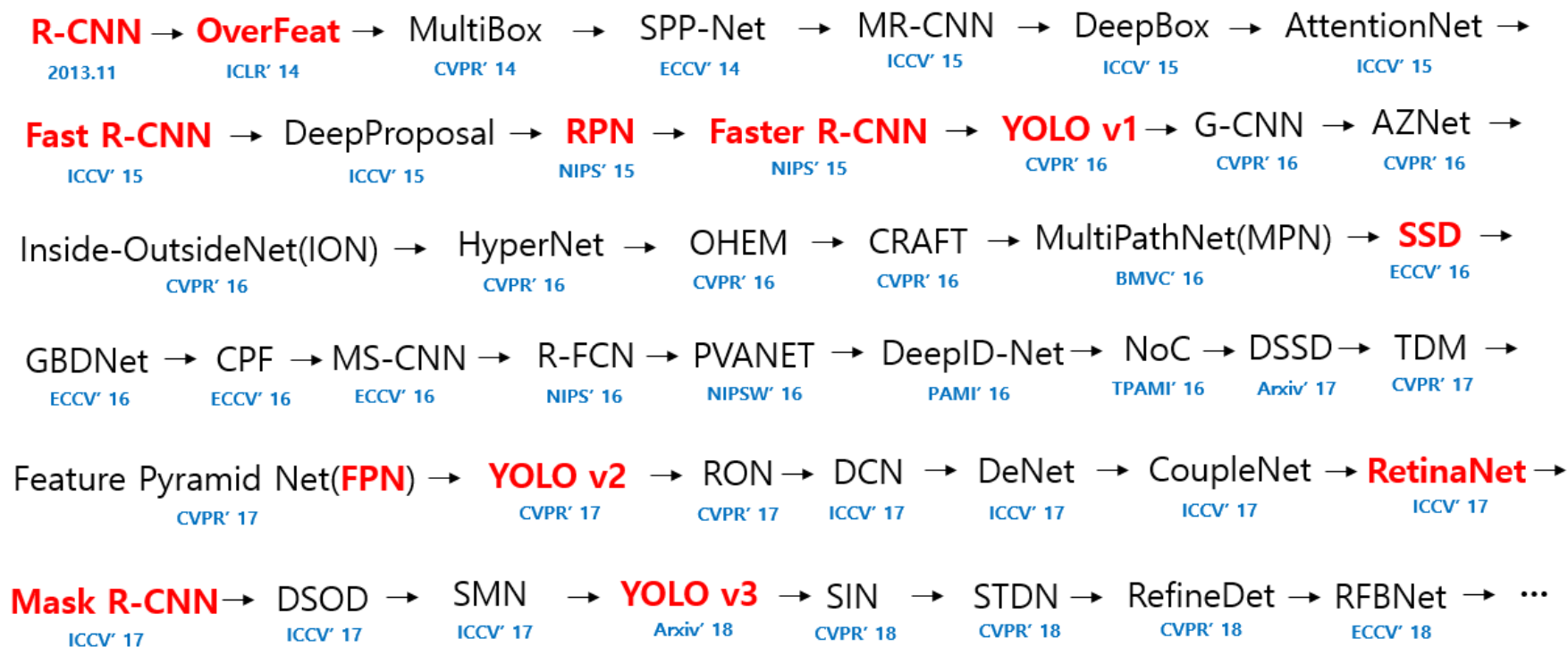


Algorithm for Semantic Segmentation

Fully Convolutional Network (FCN)



Algorithms Keep Developing



Limitation

Huge amount of training data

High processing power

Black box algorithm

Thank you!
