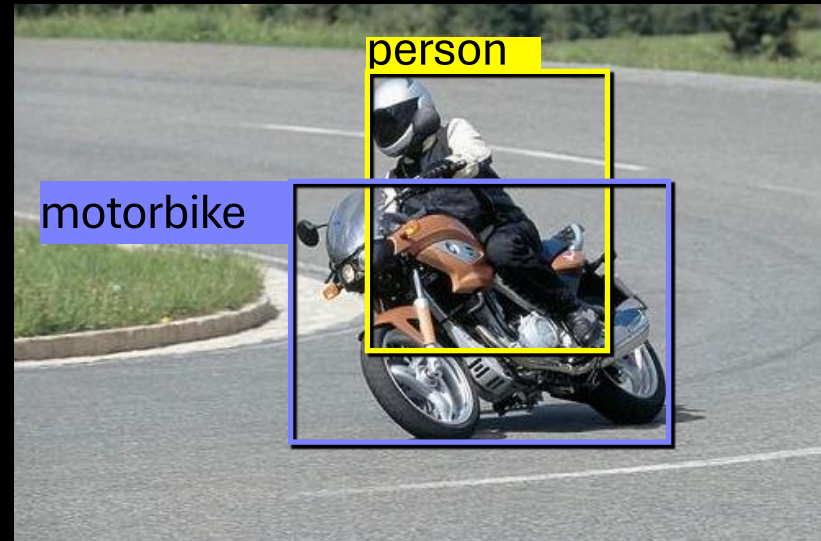


# AIL 862

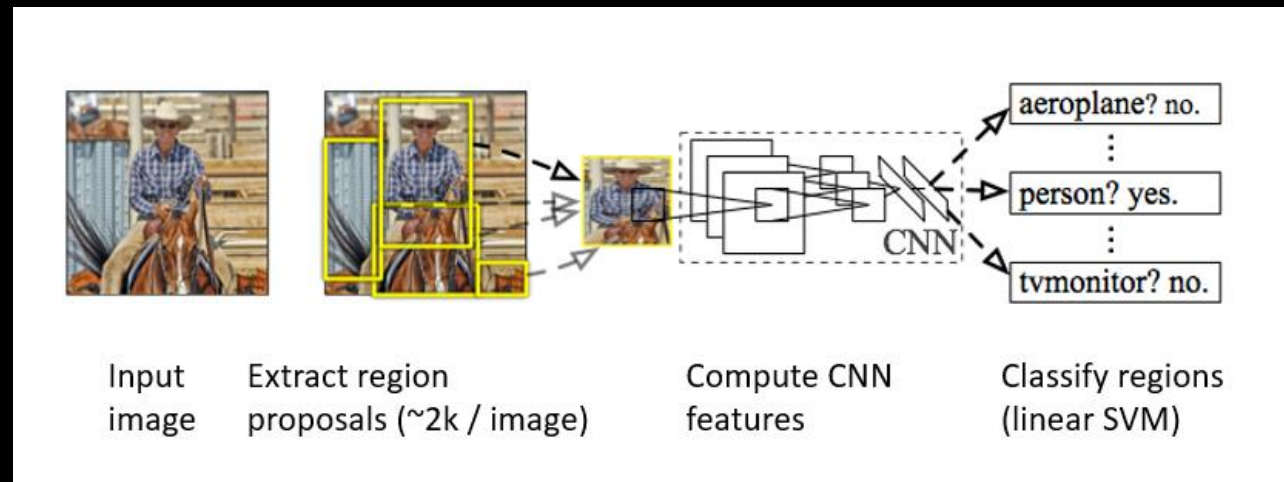
## Lecture 7

# Target Detection



# RCNN

## Step 1: Generation of category-independent region proposals

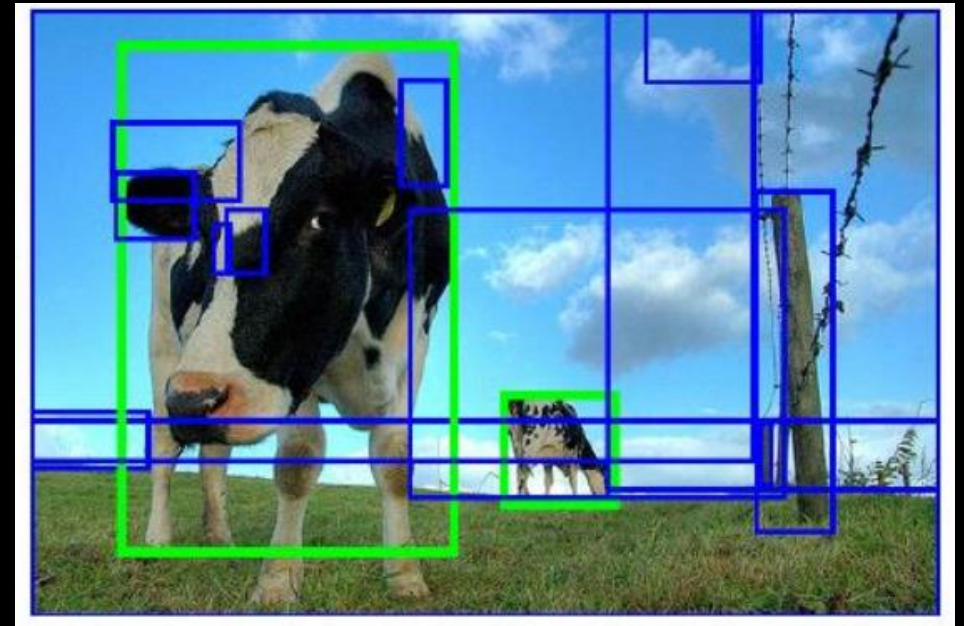


Along with  
Bounding  
box regression

Input image	Extract region proposals (~2k / image)	Compute CNN features	Classify regions (linear SVM)
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# Region Proposals

- ✓ Region proposal methods take an image as input and output bounding boxes corresponding to all patches in the image that are likely to be objects.
- ✓ The region proposals can be overlapping.
- ✓ The region proposals can be noisy.



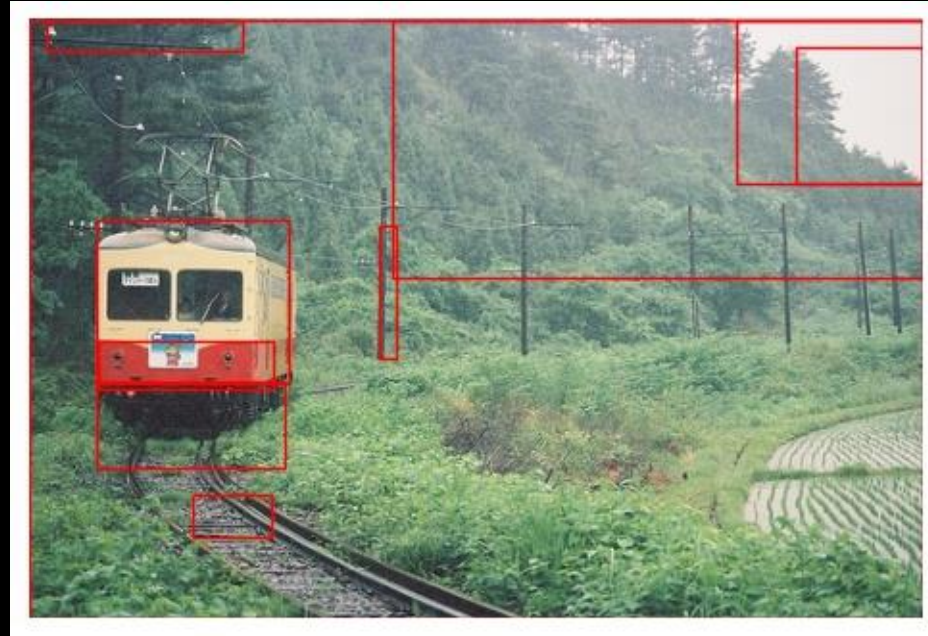
# Selective Search

## Similarity Measures

- ✓ Color
- ✓ Texture
- ✓ Size
- ✓ Fill

```
1 import skimage.io
2 import selective_search ←
3 import matplotlib.pyplot as plt
4 import matplotlib.patches as mpatches
5
6
7 # Load image as NumPy array from image files
8 inputPath = './inputImages/trainScene.jpg'
9 image = skimage.io.imread(inputPath)
10 image = image[:, :, 0:3]
11
12 # Run selective search using single mode
13 boxes = selective_search.selective_search(image, mode='single', random_sort=False) ←
14 boxes_filter = selective_search.box_filter(boxes, min_size=5, topN=10)
15
```

# Selective Search



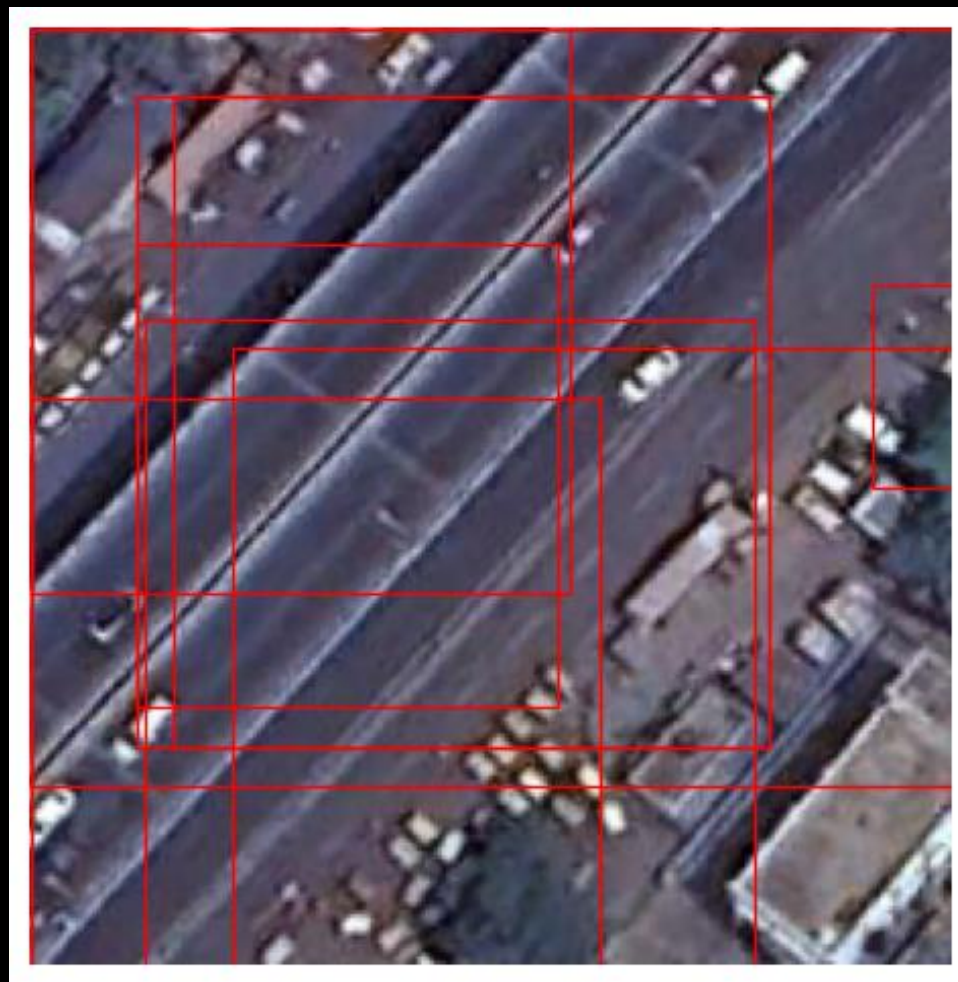
# Selective Search



- ✓ A marine aerial image showing ships
- ✓ We just generated 10 proposals, so 1 ship was not detected

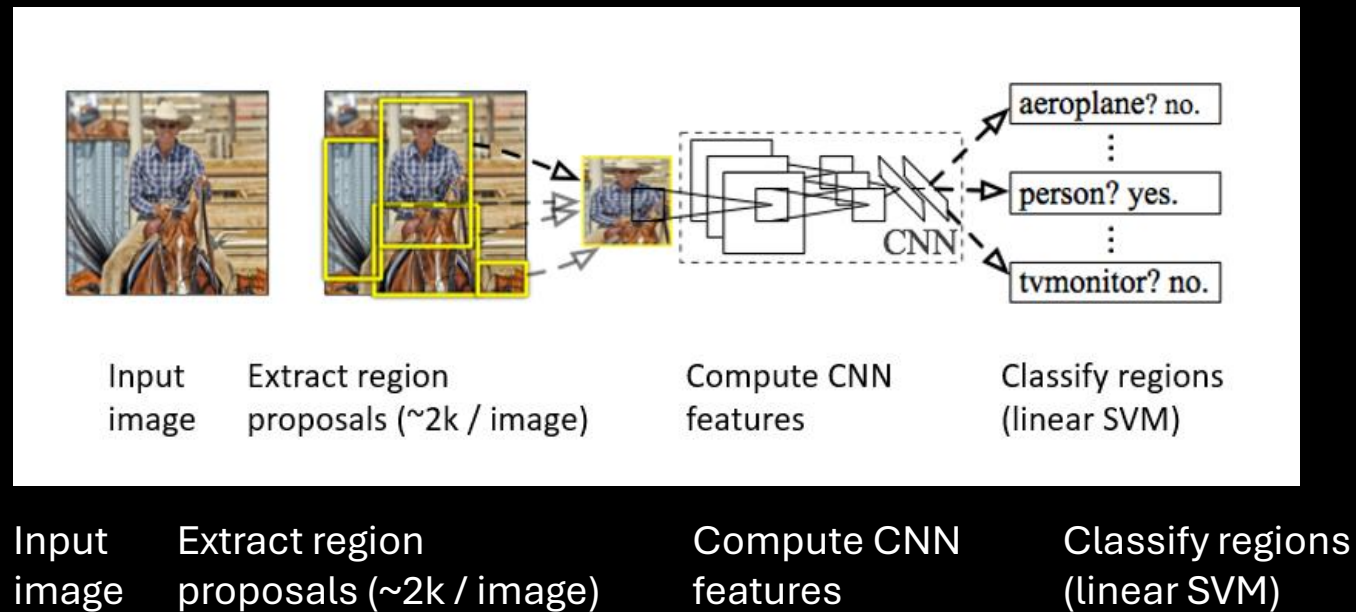


# Selective Search

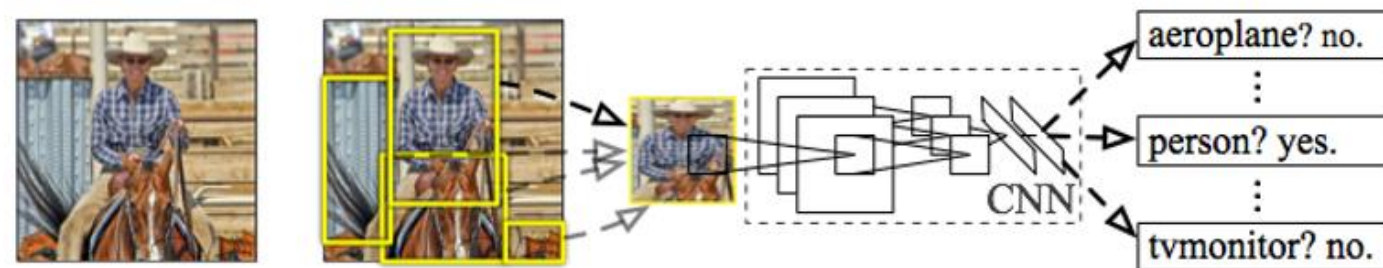


# RCNN

Step 2: Extraction of fixed size feature vectors from each proposal



# RCNN



Input  
image

Extract region  
proposals (~2k / image)

Compute CNN  
features



a. Crop

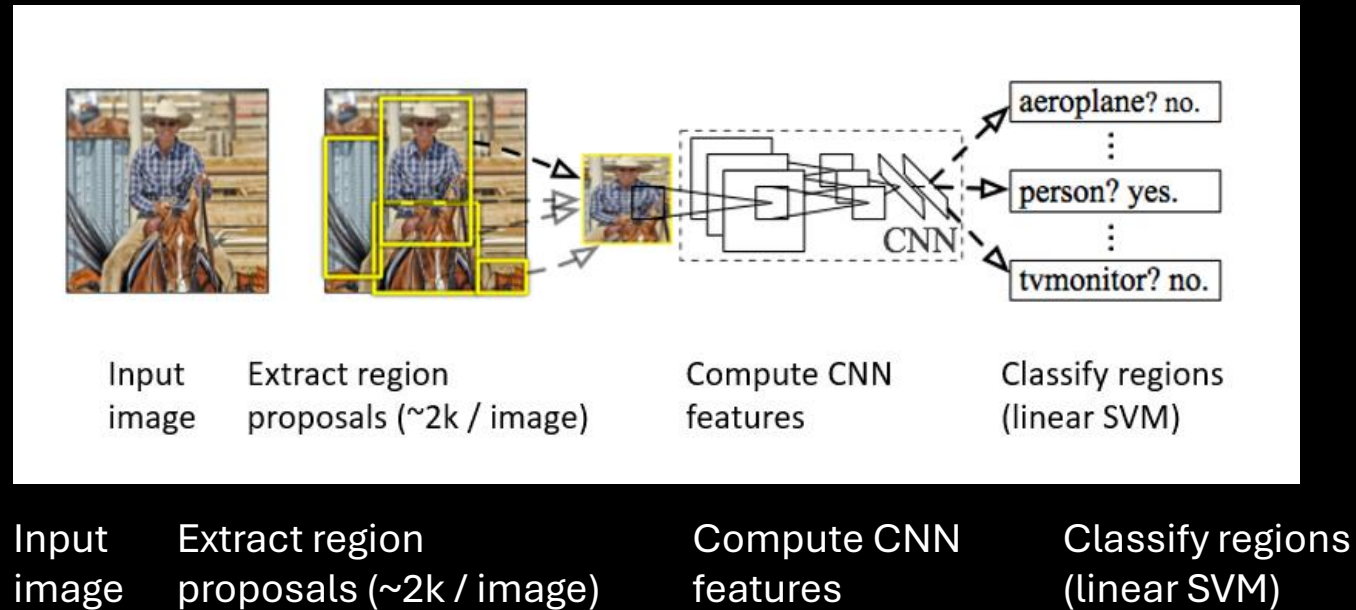


227 x 227

b. Scale

# RCNN

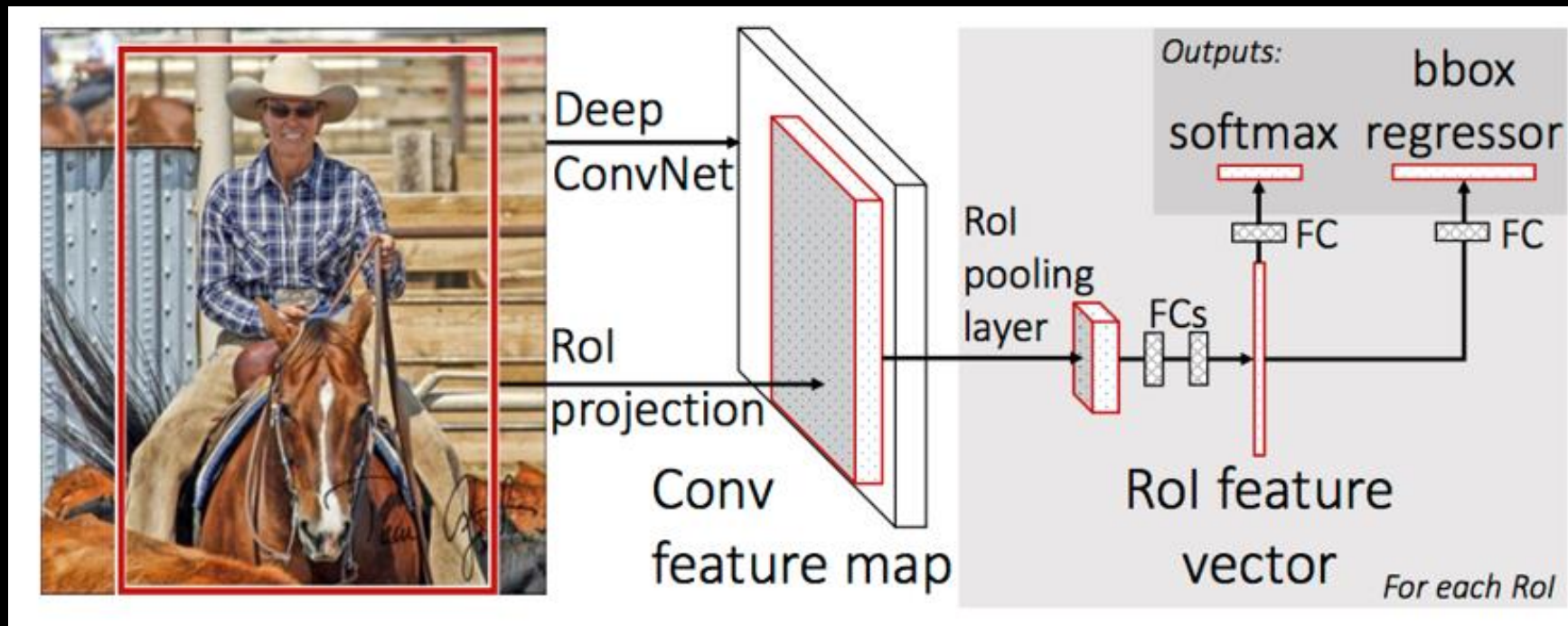
Step 3: Classify using a set of class-specific linear SVMs



# RCNN

- Processes each ROI through CNN (computationally expensive).

# Fast RCNN

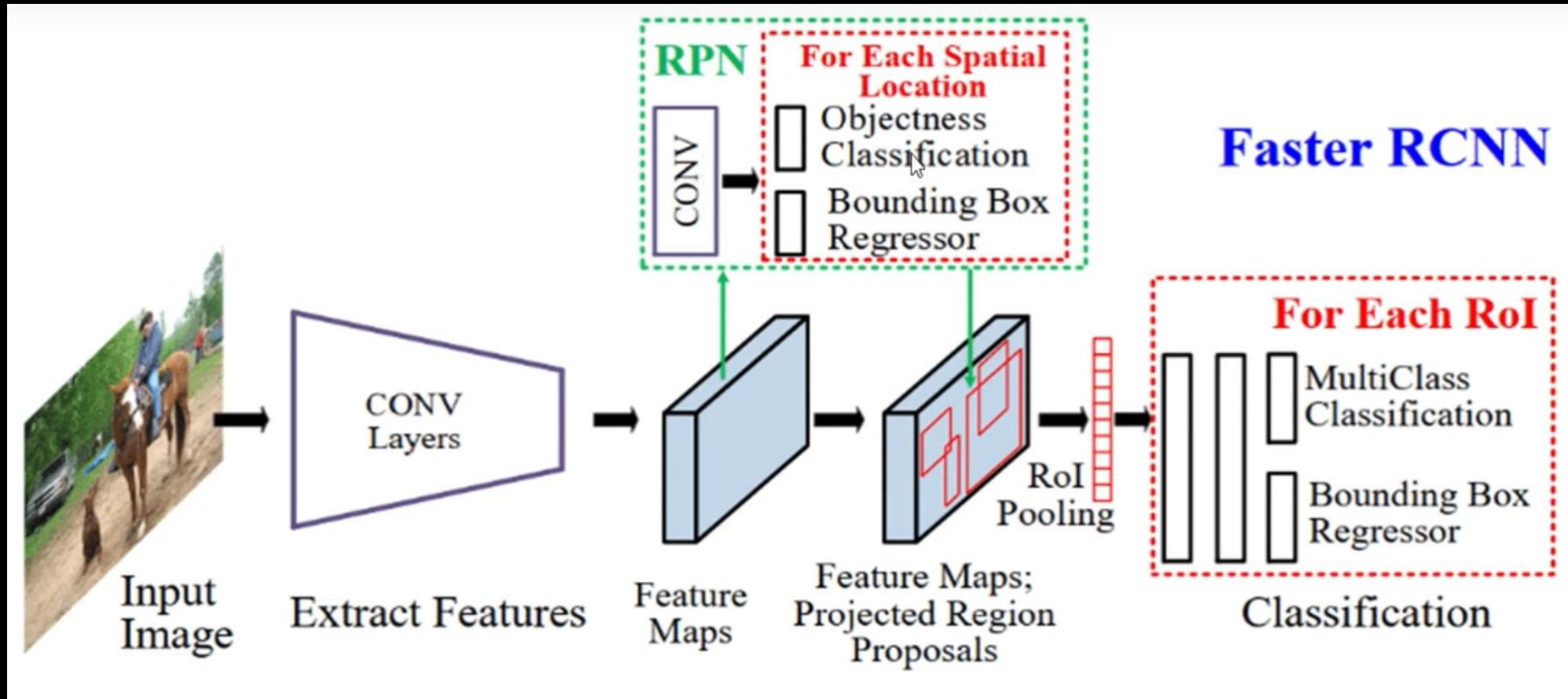


# ROI Pooling

- Converts variable-sized ROIs into a uniform size (e.g.,  $7 \times 7$ ).
- Divide each ROI into a fixed number of grid cells and perform (max) pooling over each grid.



# Faster RCNN



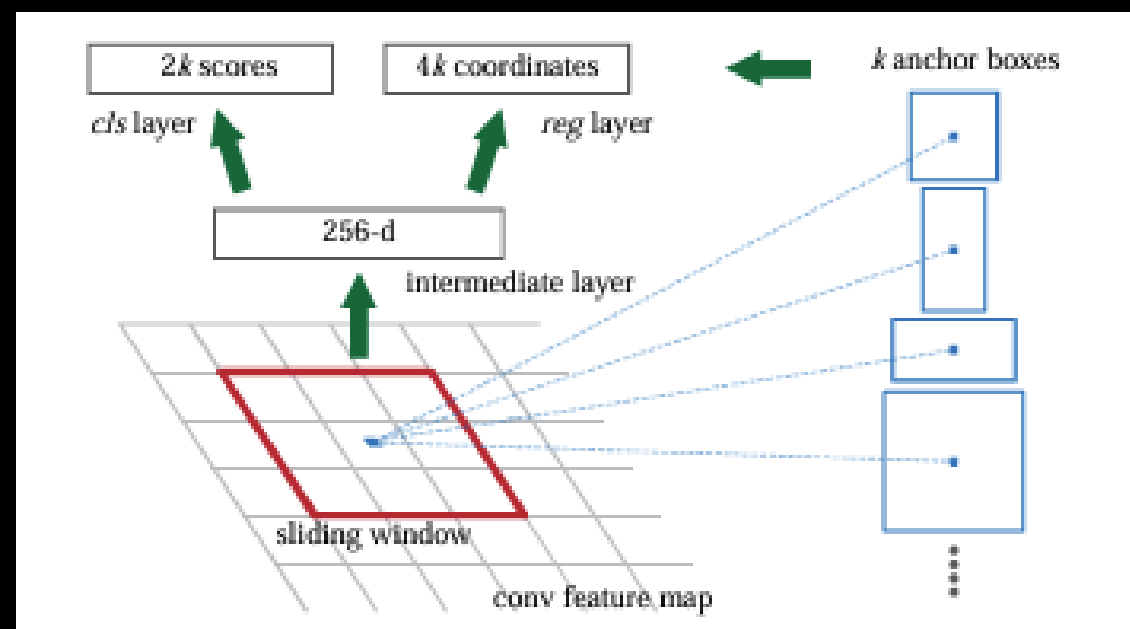


# Region Proposal Network

- Designed to replace traditional methods like Selective Search.
- Generates region proposals directly from feature maps.
- Operates in a fully convolutional manner.
- Outputs bounding boxes and corresponding Objectness scores.

# Region Proposal Network

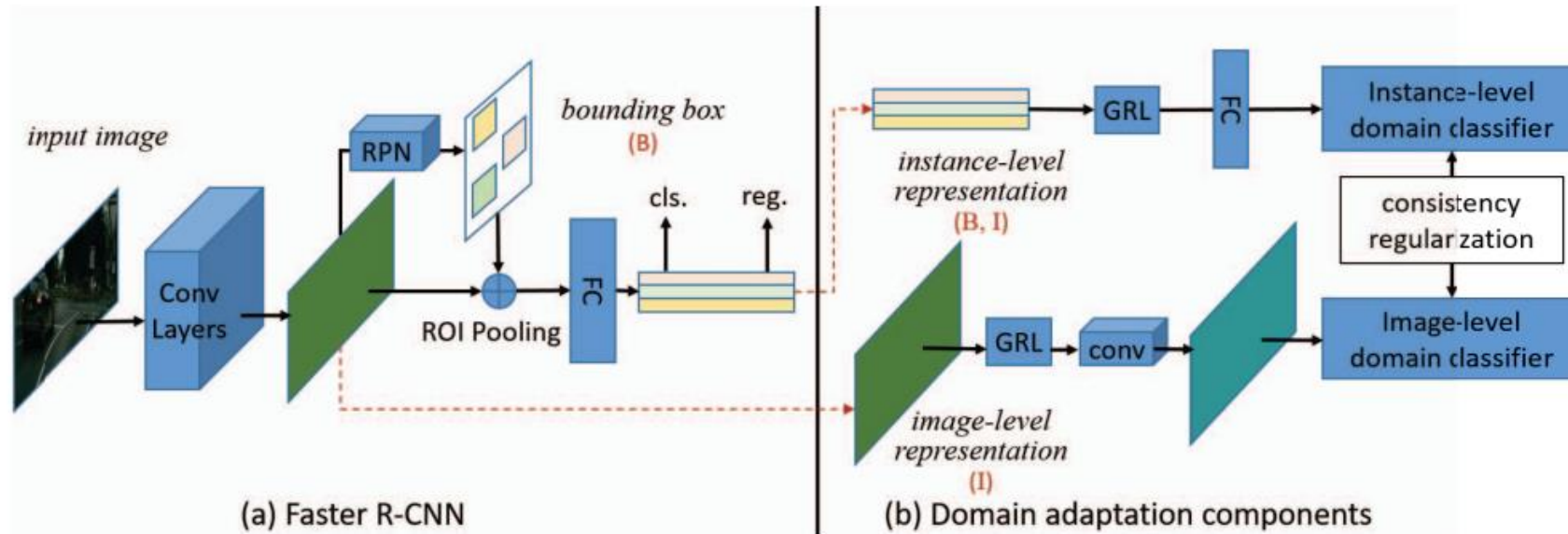
- Input feature map (from backbone CNN).
- A sliding window is applied across the feature map.
- At each position, it predicts:  $k$  anchor boxes (bounding boxes of different scales and aspect ratios), scores for each anchor: object vs. background, and coordinates per anchor: adjustments to refine anchor positions.
- Non-maximum suppression is used to filter (highly) overlapping proposals.



# Faster RCNN+DA

- How?

# Faster RCNN+DA



# Mask RCNN

- Input Image → Backbone (e.g., ResNet) → Feature Map.
- RPN → Propose Regions (ROIs).
- ROIAlign → Extract precise features.
- Tasks: Classify the object. Refine the bounding box. Predict the mask for the object (pixel-level).

YOLO

# Oil Well Detection

- From high resolution remote sensing images
- Essential information for energy industry
- Challenging – small target



# Oil Well Detection

Figure 9. False detection cases of Faster R-CNN (blue boxes are true positives, red boxes are false positives).



Optimized faster R-CNN for oil wells detection from high-resolution remote sensing images

# Oil Well Detection

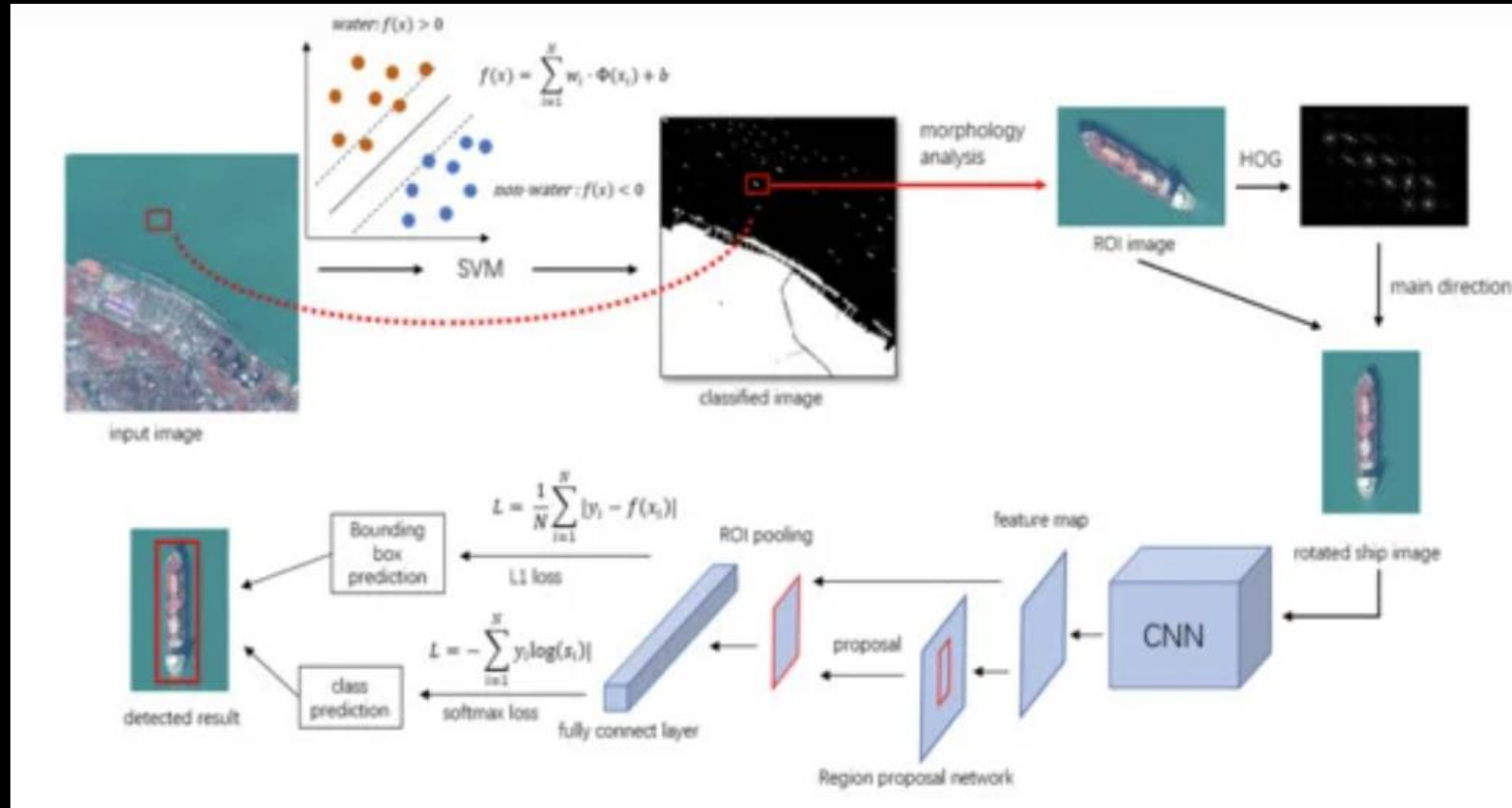
What helped

- ✓ Feature extraction backbone – replacing the VGG16 network with the ResNet50
- ✓ Substituting the ordinary convolution of ResNet with a dilated convolution to improve the model's receptive field
- ✓ Adding an edge detection module

# Ship Detection

- In the harbor
- In the sea

# Ship Detection



R-CNN-Based Ship Detection from High Resolution Remote Sensing Imagery

# Ship Detection

- Hard negative mining has been found to be useful in some works.

# Vehicle Detection

- Some Pre/post-processing?

# Collaborating Foundation Models for Domain Generalized Semantic Segmentation

Abhishek

DiffusionDet : Diffusion Model for Object Detection

Kanishk