LAB 6 - RCNN AND FASTER RCNN

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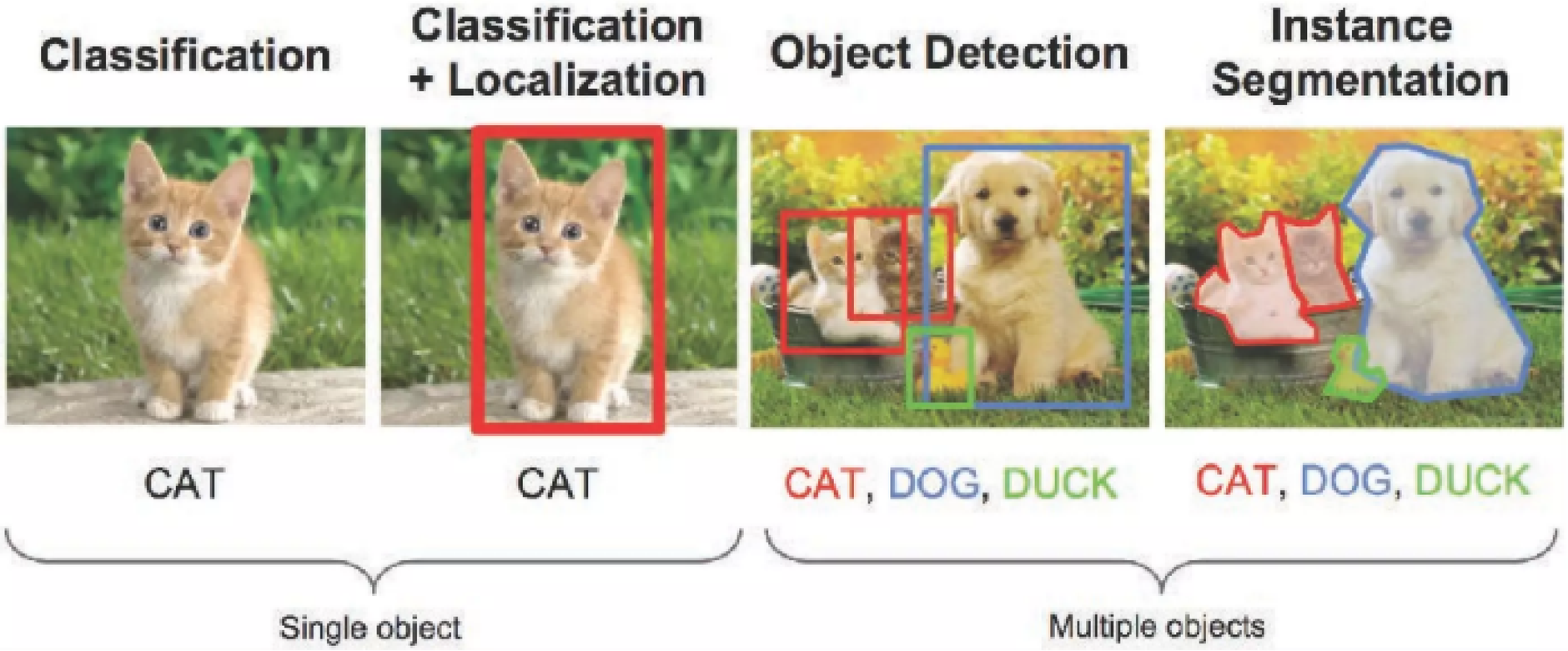
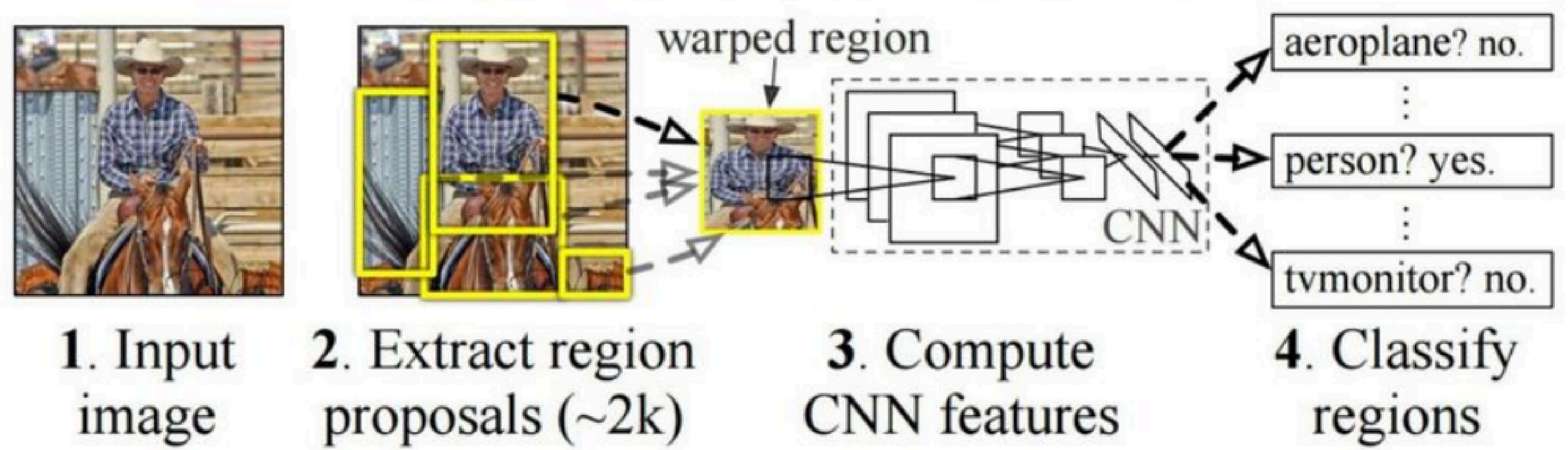
COMPUTER VISION TASKS

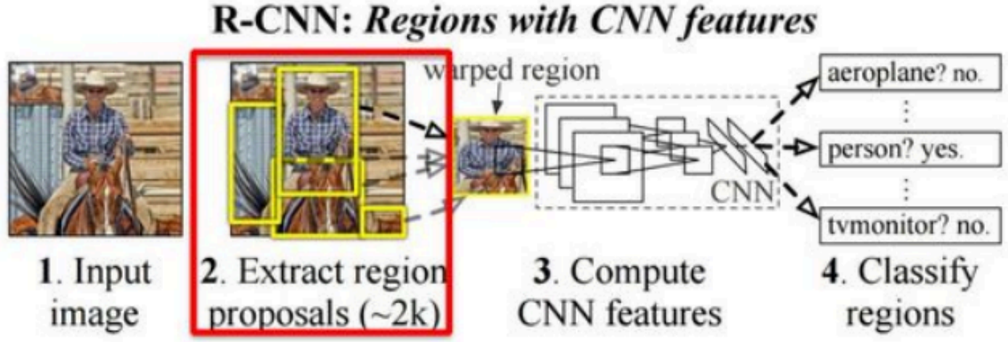


R-CNN: REGIONS WITH CNN FEATURES



R-CNN: REGIONS WITH CNN FEATURES

- First Stage: generate category-independent region proposals.
  - 2000 Region proposals every image.



Selective Search: Combining strengths of both exhaustive search and segmentation.

SELECTIVE SEARCH ALGORITHM

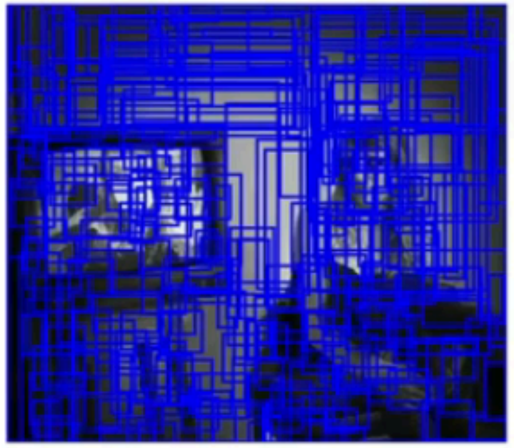
Designed to have high recall, but low precision

equivalent to…

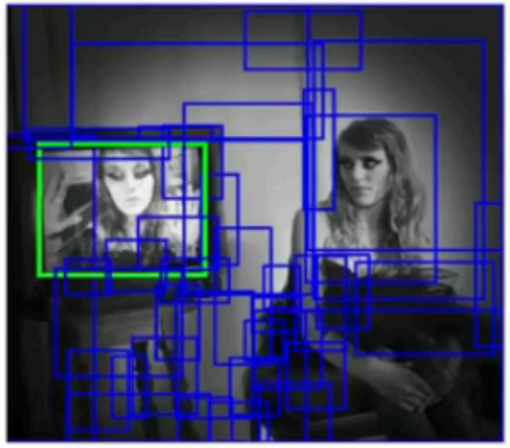
Return many false positive regions, but we are quite certain that they contain the objects of interest

SELECTIVE SEARCH ALGORITHM

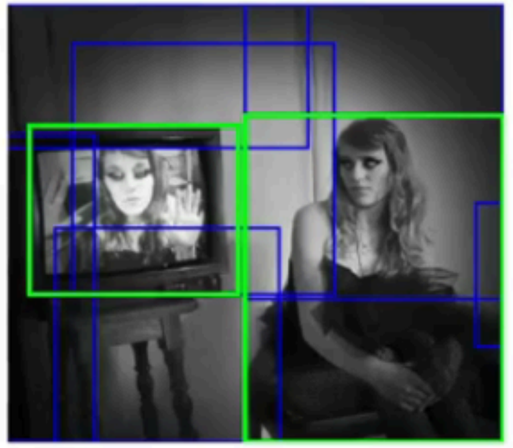
Seed regions



Iteration 1

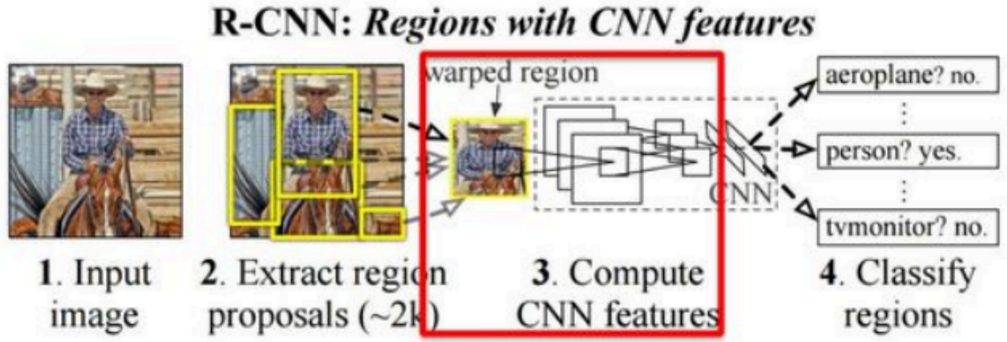


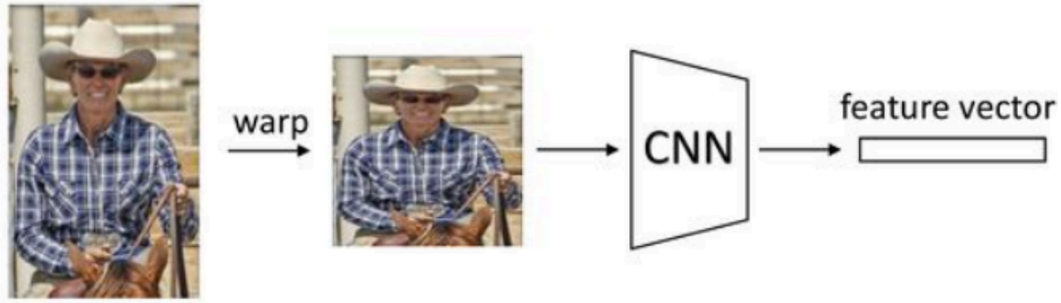
Iteration 2



R-CNN: REGIONS WITH CNN FEATURES

- First Stage: generate category-independent region proposals.
  - 2000 Region proposals every image.
- Second Stage: Extract a fixed length feature vector from each region.
  - a 4096-dimensional feature vector from each region proposal.



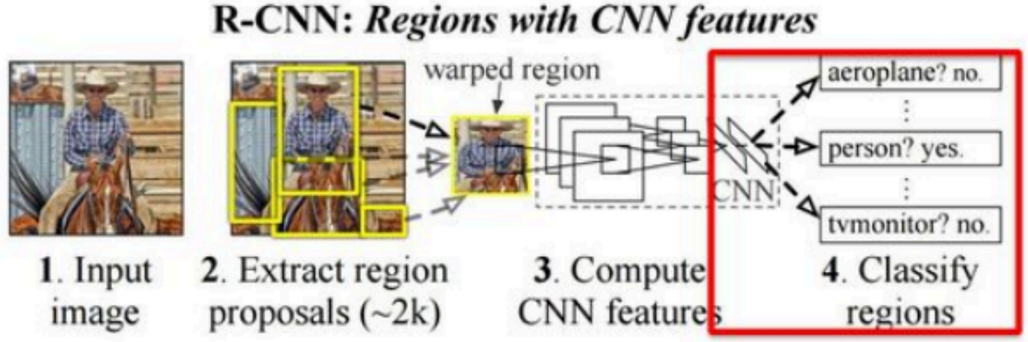


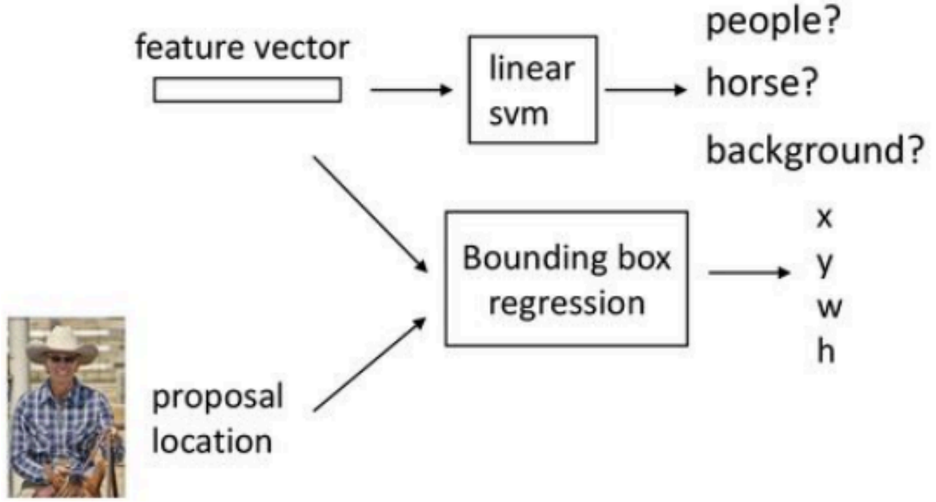
Arbitrary rectangles?
A fixed size input? 227 x 227

5 conv layers + 2 fully connected layers

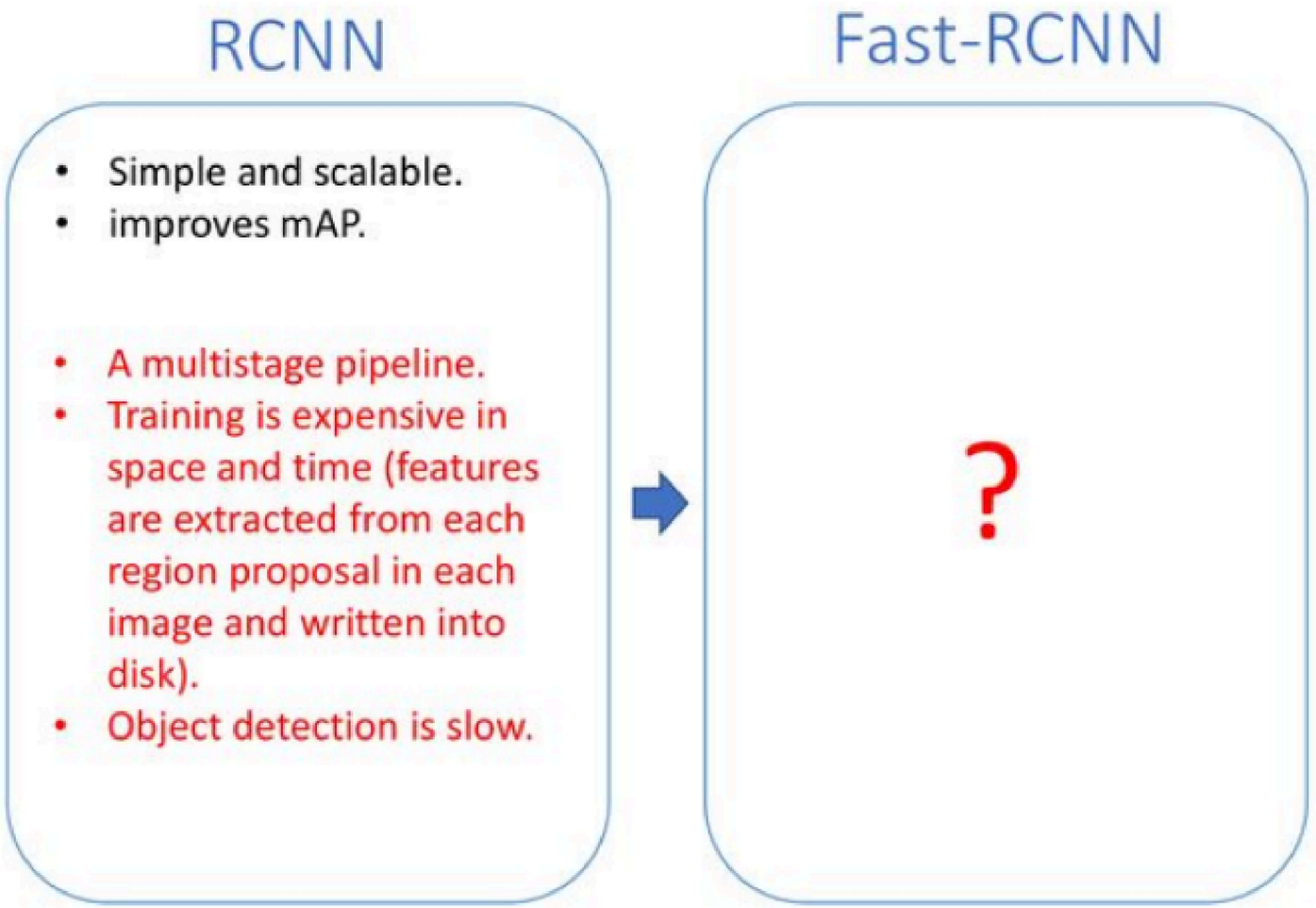
R-CNN: REGIONS WITH CNN FEATURES

- First Stage: generate category-independent region proposals.
  - 2000 Region proposals every image.
- Second Stage: Extract a fixed length feature vector from each region.
  - a 4096-dimensional feature vector from each region proposal.
- Third Stage: a set of class-specific linear SVMs.
  - object category and localization.

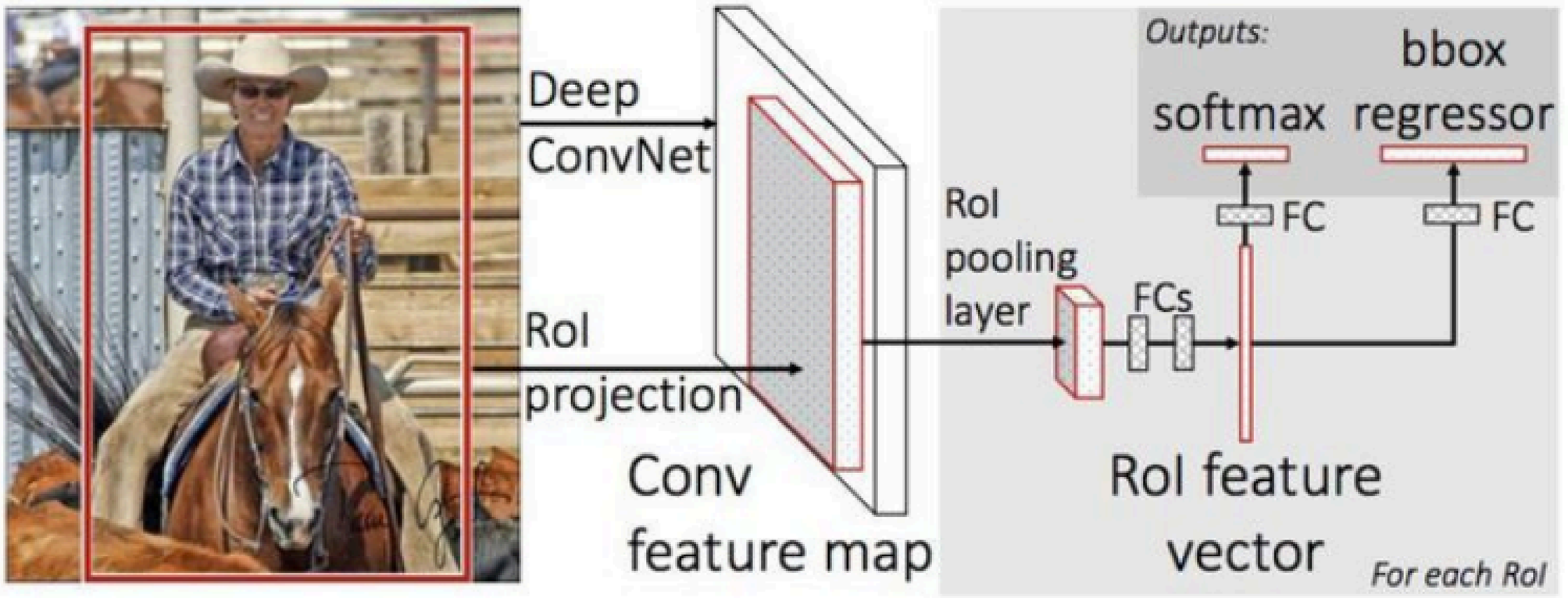




WHY DO WE NEED FAST RCNN?

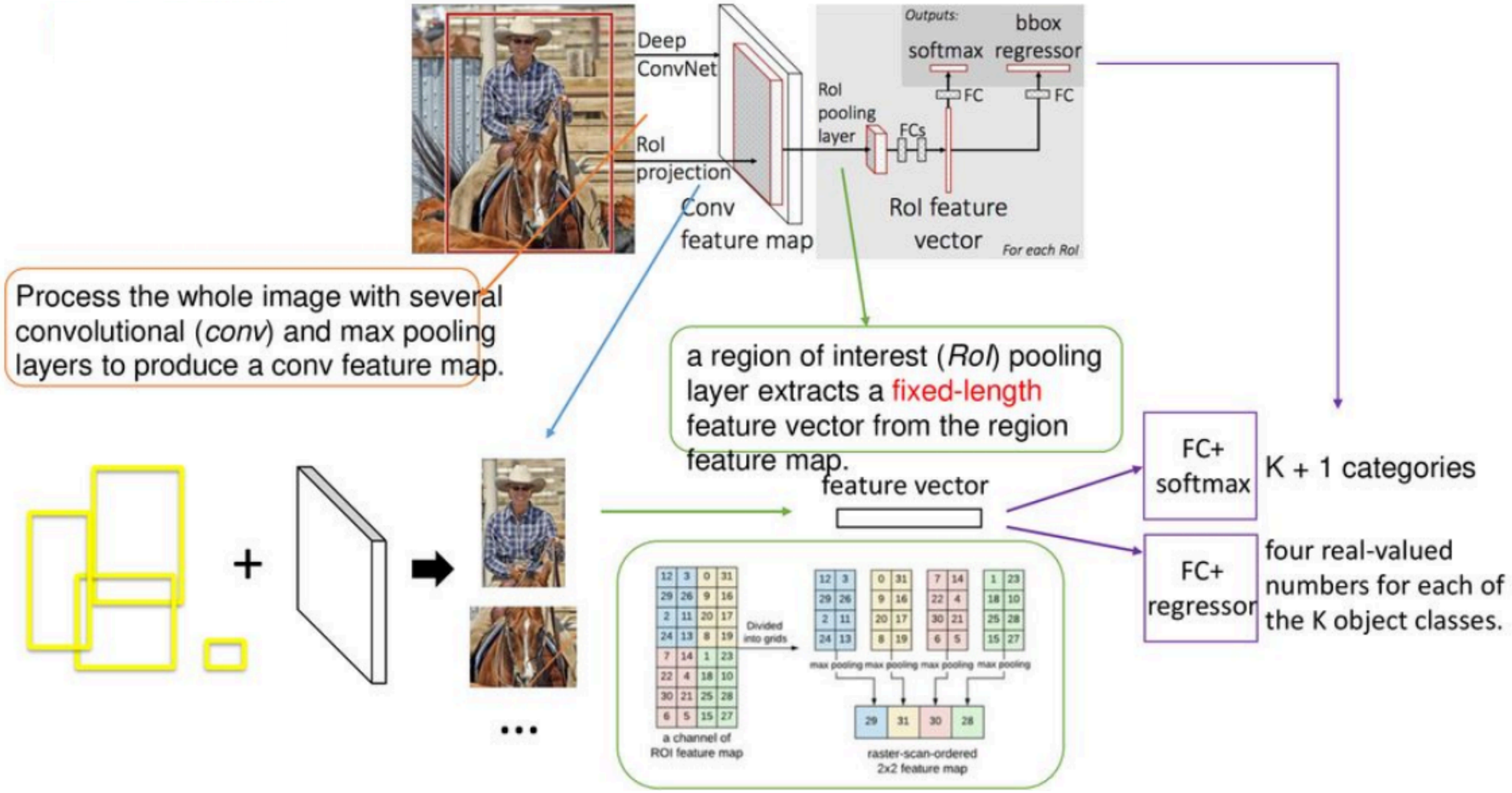


FAST R-CNN

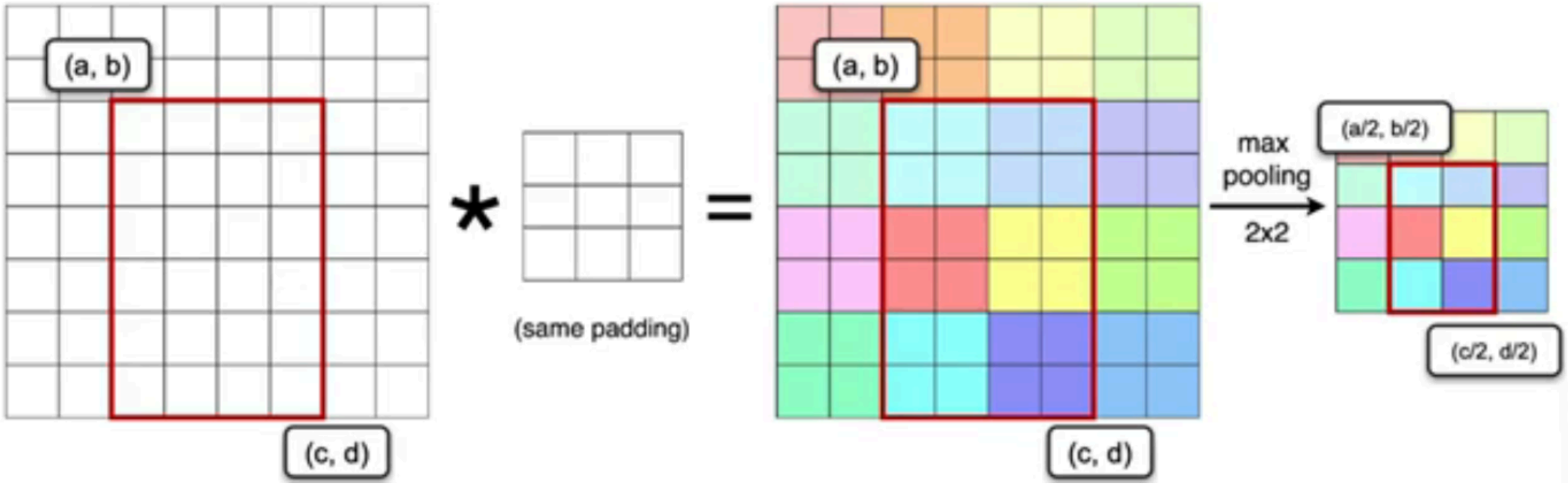


Idea: No need to recompute features for each box independently.

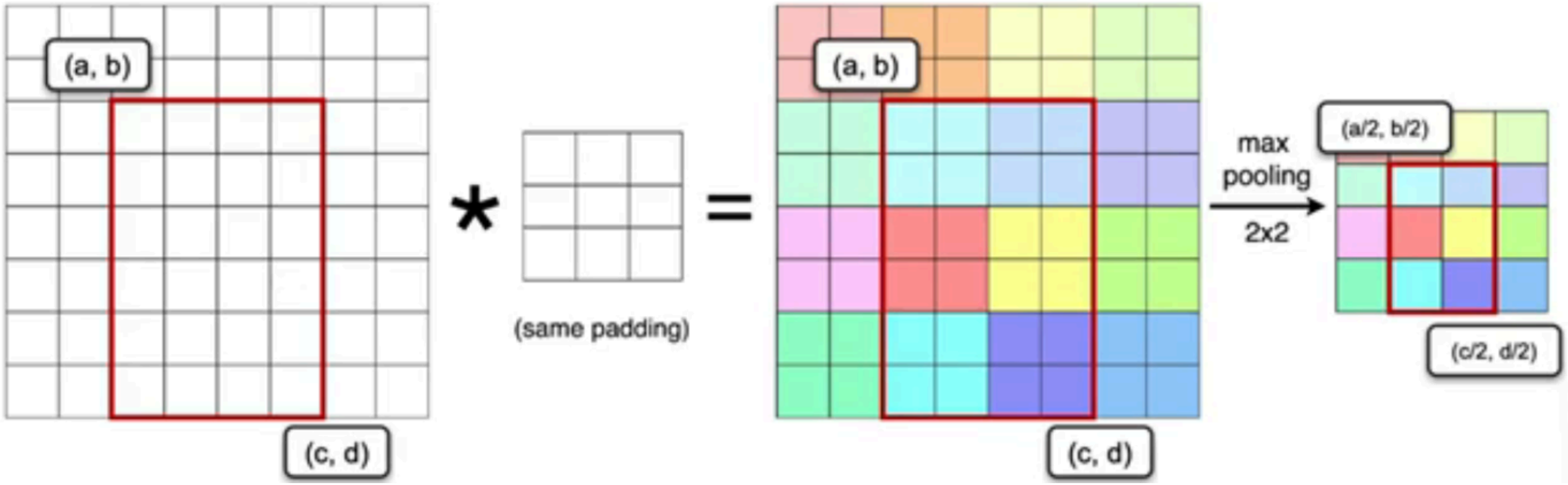
FAST R-CNN


Deep ConvNet
RoI projection
Conv feature map
Outputs:
softmax
bbox regressor
FC
FC
RoI pooling layer
FCs
RoI feature vector
For each RoI
Process the whole image with several convolutional (conv) and max pooling layers to produce a conv feature map.
a region of interest (RoI) pooling layer extracts a fixed-length feature vector from the region feature map.
feature vector
FC+ softmax
K + 1 categories
FC+ regressor
four real-valued numbers for each of the K object classes.
Divided into grids
max pooling
a channel of RoI feature map
raster-scan-ordered 2x2 feature map

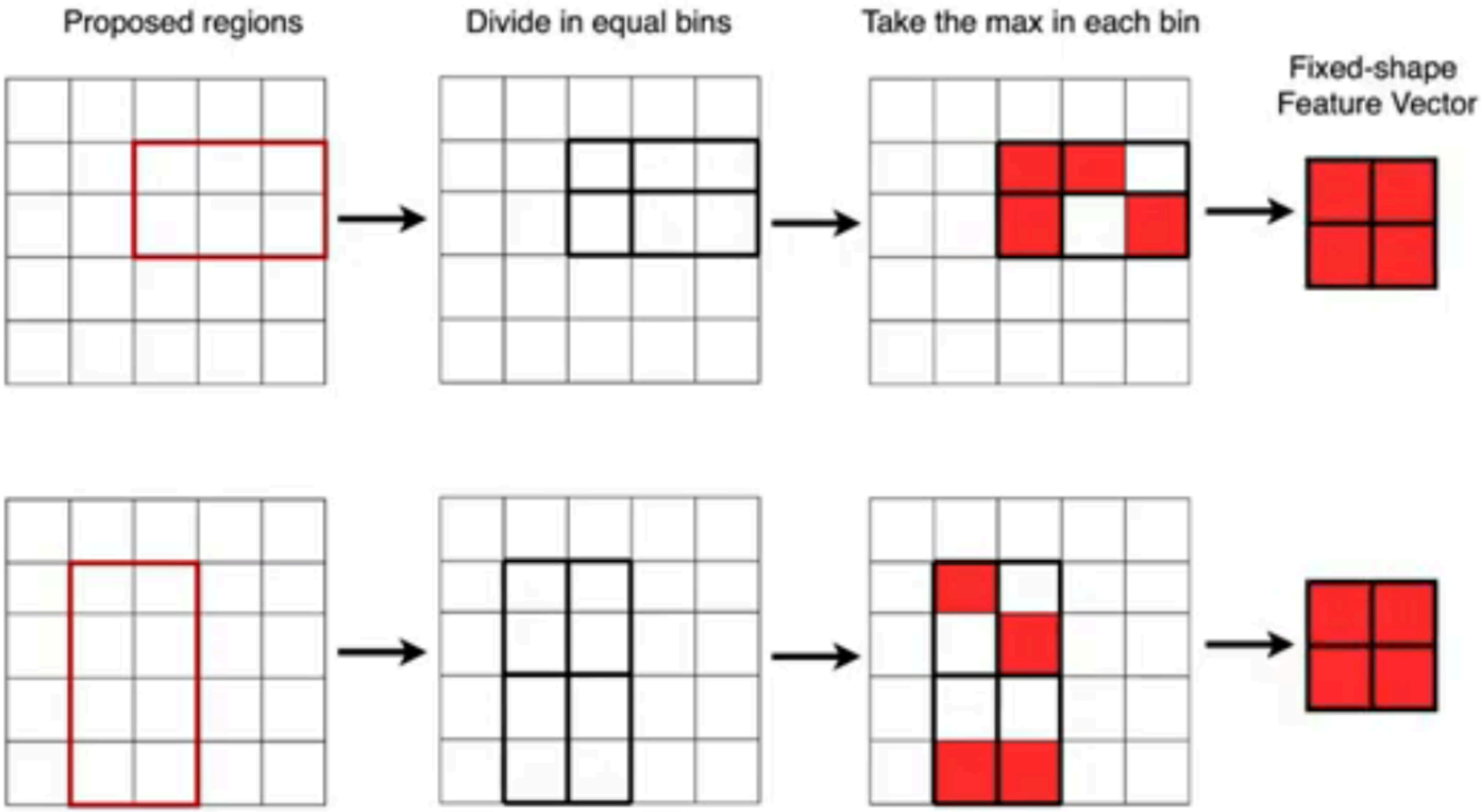
ROI PROJECTION



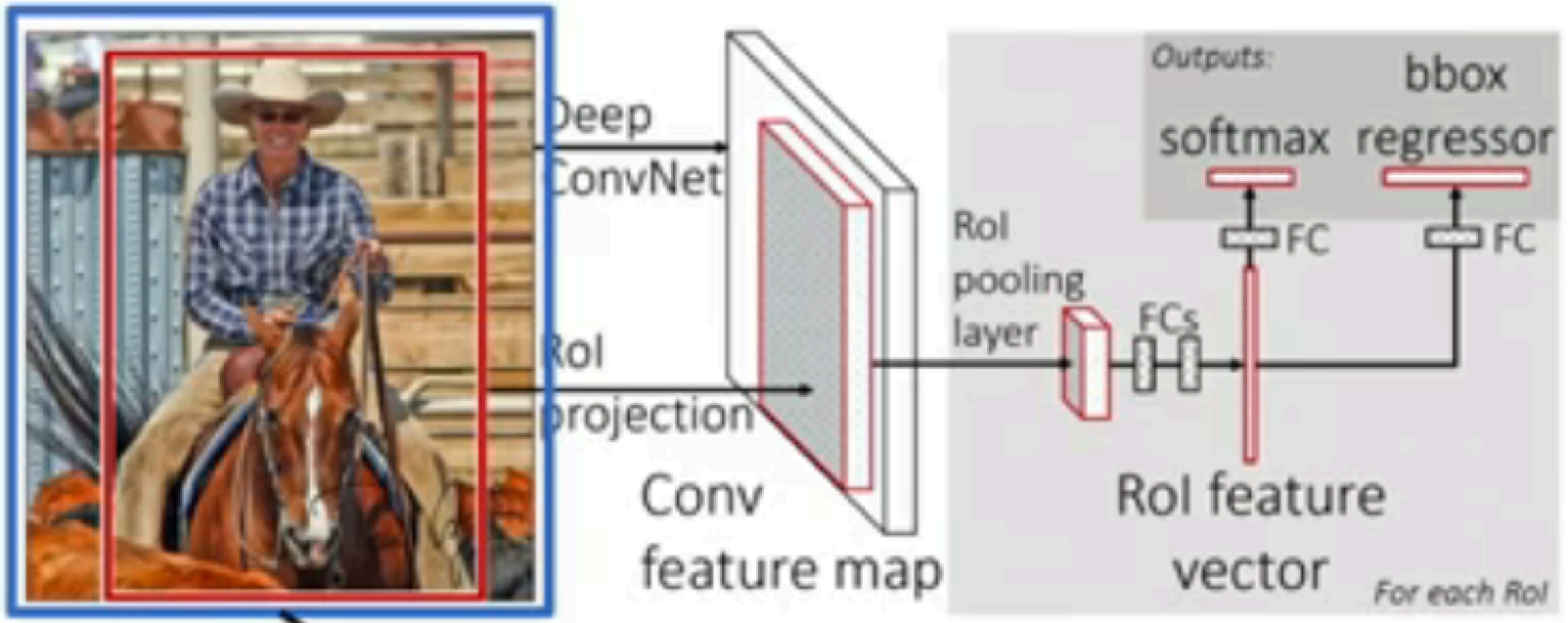
ROI PROJECTION



ROI POOLING

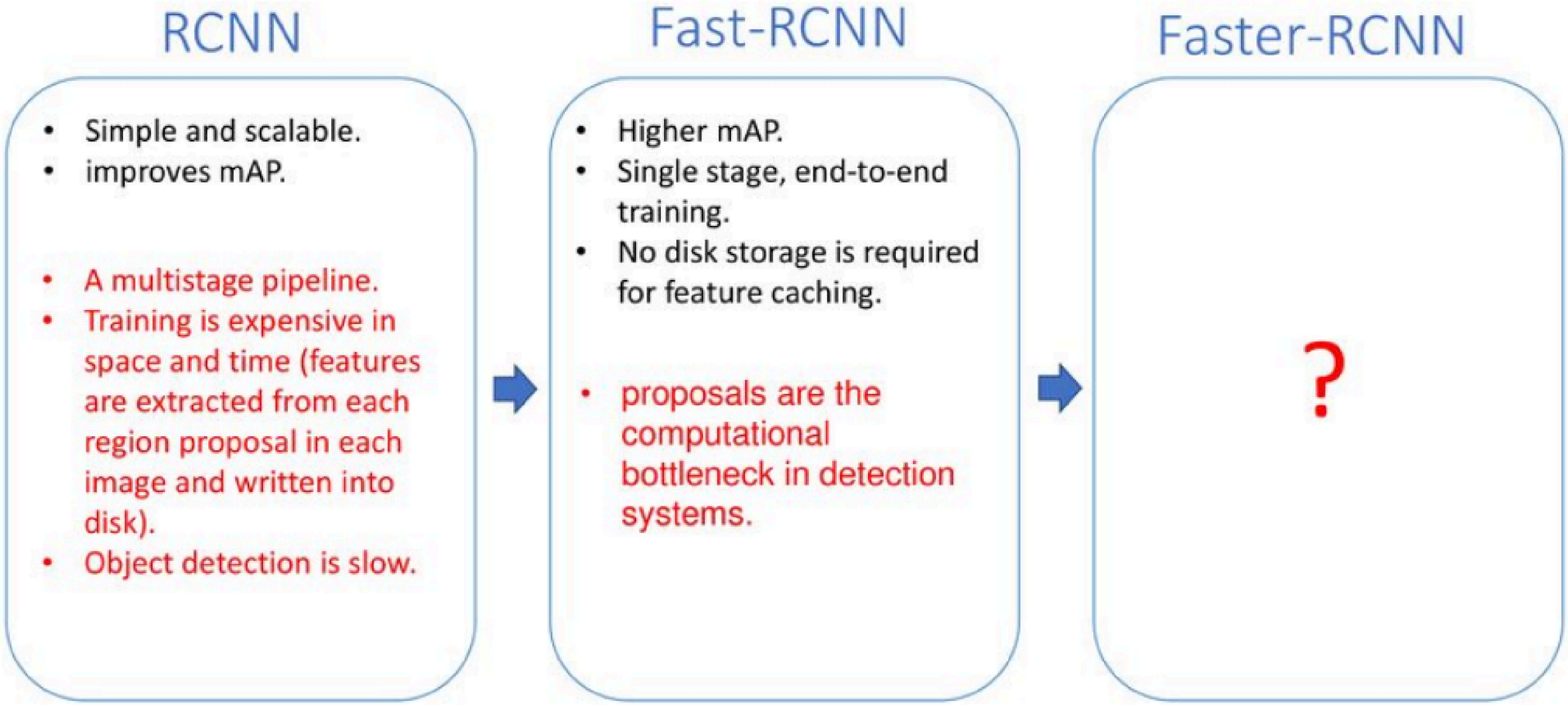

Proposed regions
Divide in equal bins
Take the max in each bin
Fixed-shape
Feature Vector

FAST RCNN ISSUES



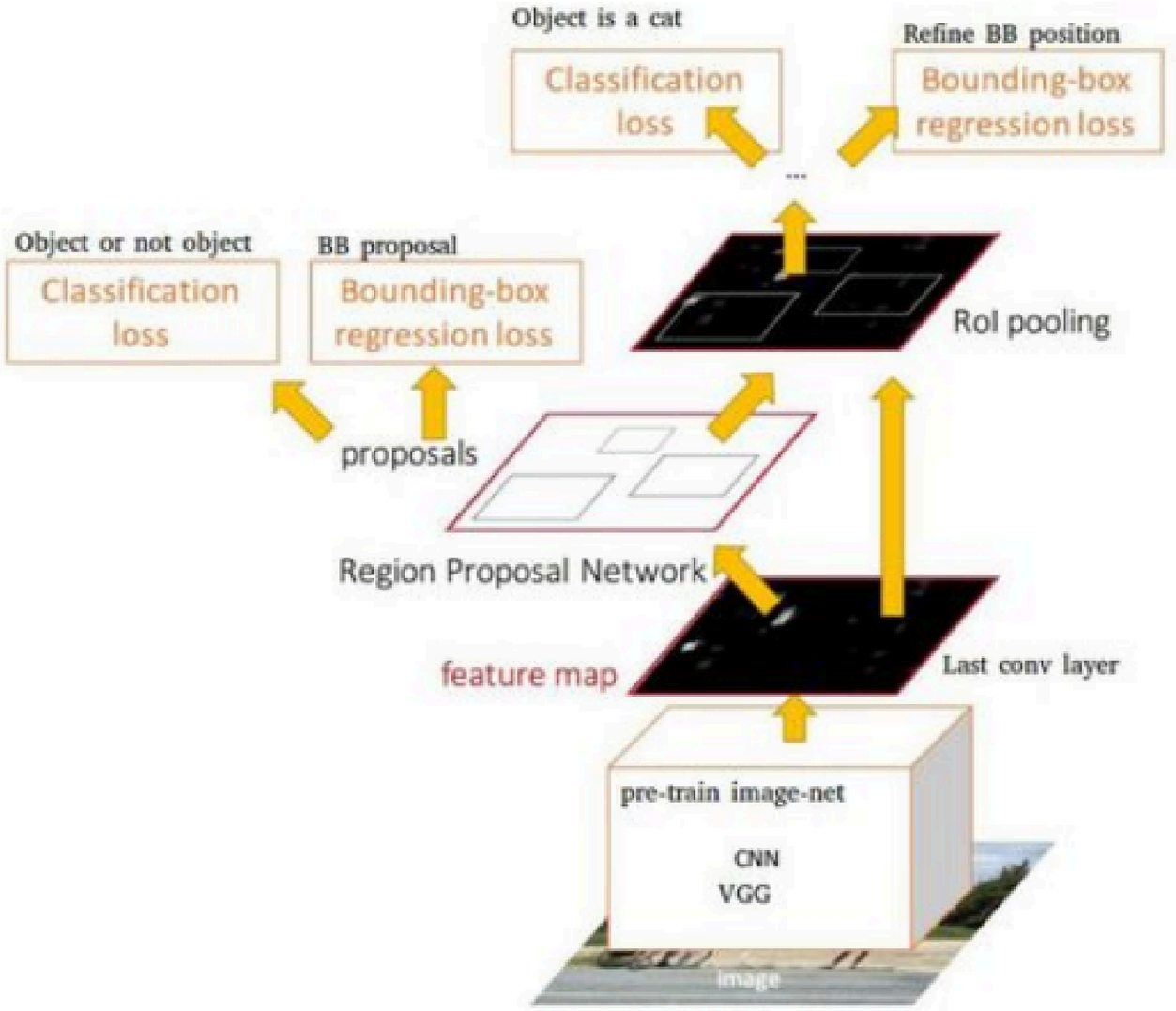
The region proposal algorithm is an external algorithm that was not specifically tuned for the object detection task at hand

WHY DO WE NEED FASTER RCNN?

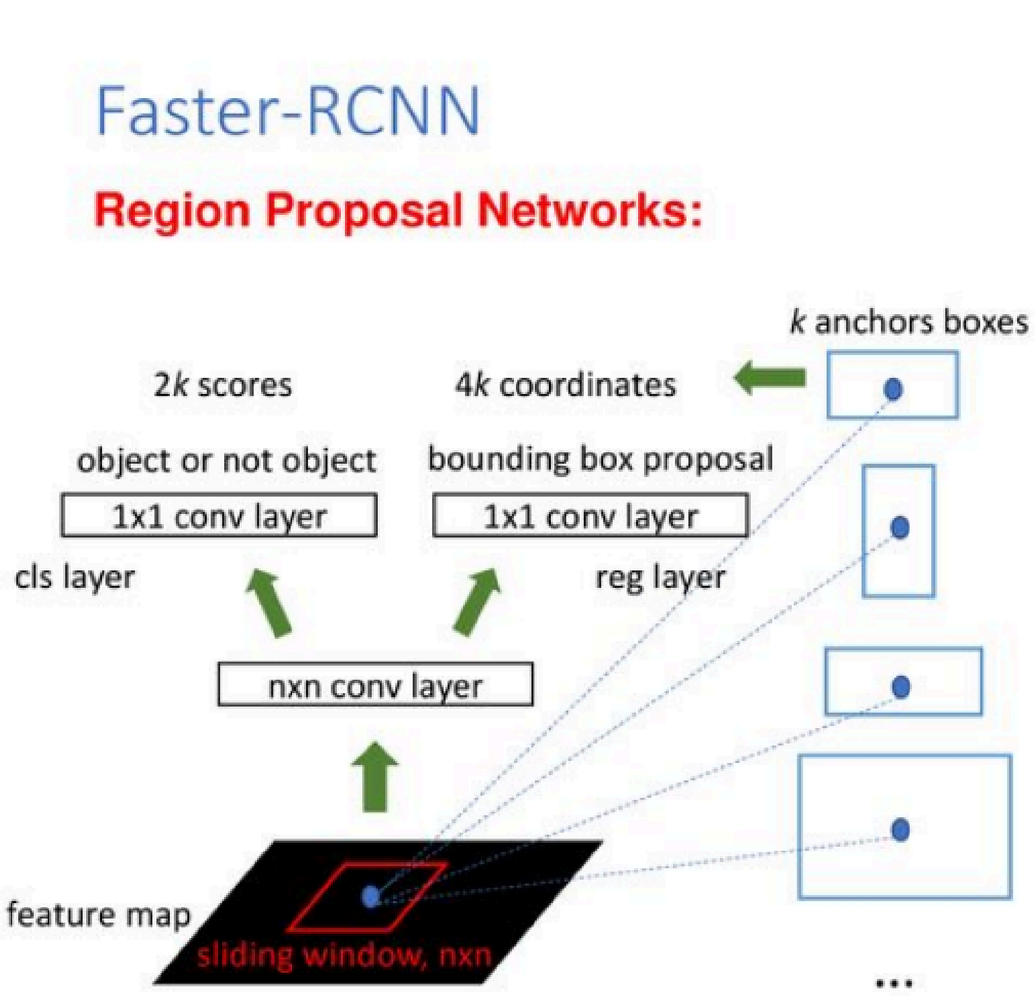


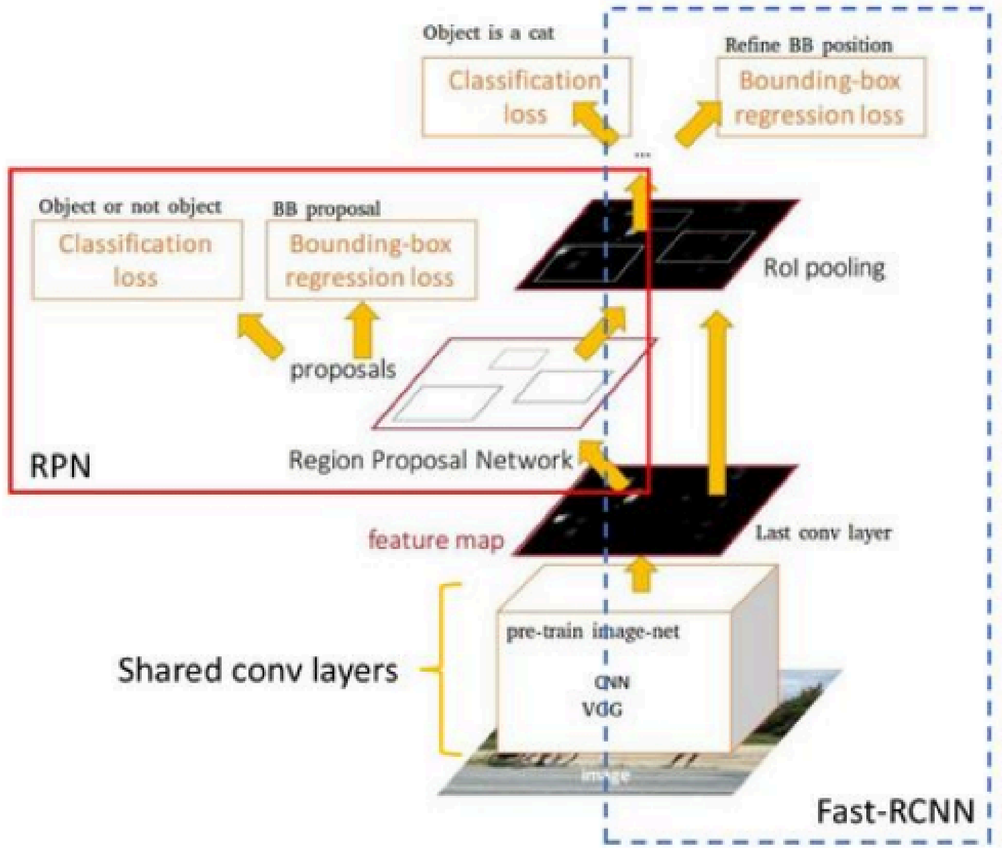
FASTER R-CNN

Idea: Integrate the bounding box proposals as part of the CNN predictions.

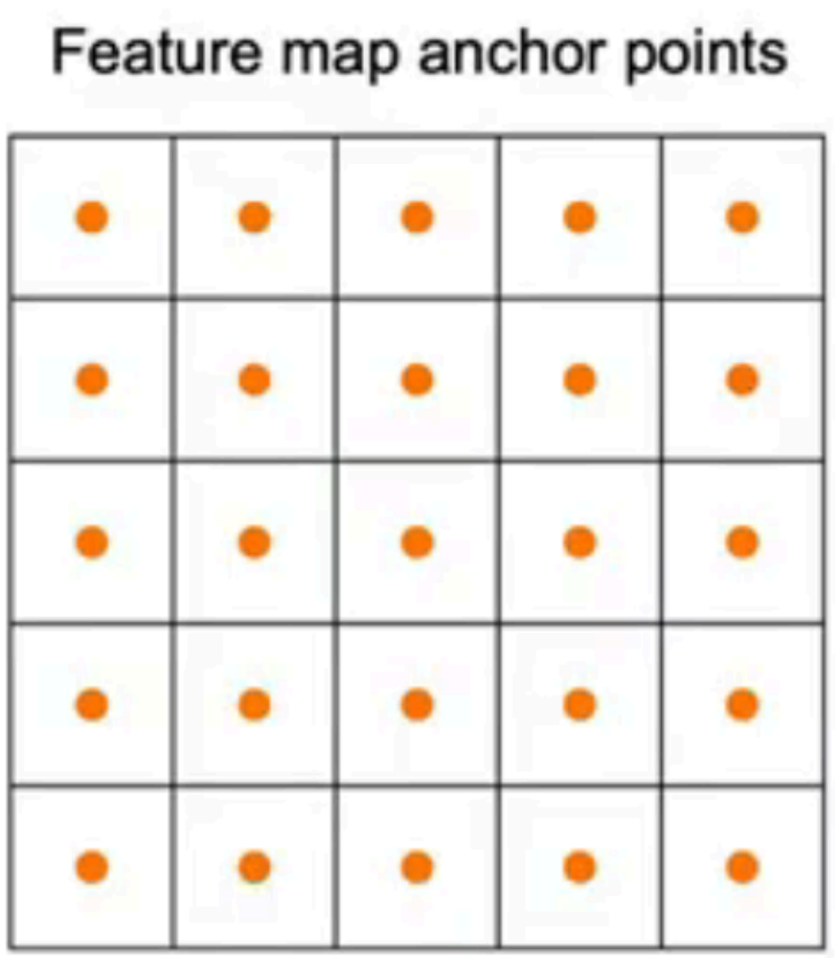


FASTER R-CNN

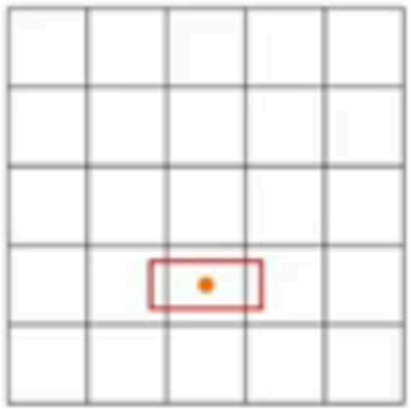

Faster-RCNN
Region Proposal Networks:
k anchors boxes
2k scores
4k coordinates
object or not object
bounding box proposal
1x1 conv layer
1x1 conv layer
cls layer
reg layer
nxn conv layer
feature map
sliding window, nxn
...

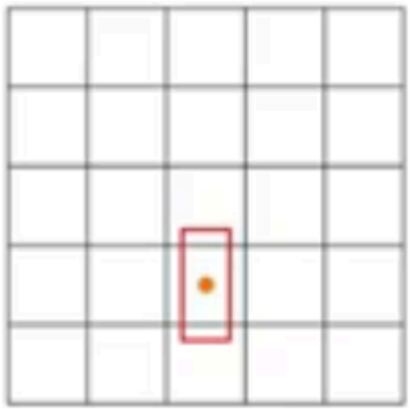

Object is a cat
Refine BB position
Classification loss
Bounding-box regression loss
...
Object or not object
BB proposal
Classification loss
Bounding-box regression loss
RoI pooling
proposals
RPN
Region Proposal Network
feature map
Last conv layer
Shared conv layers
pre-train image-net
CNN
VGG
image
Fast-RCNN

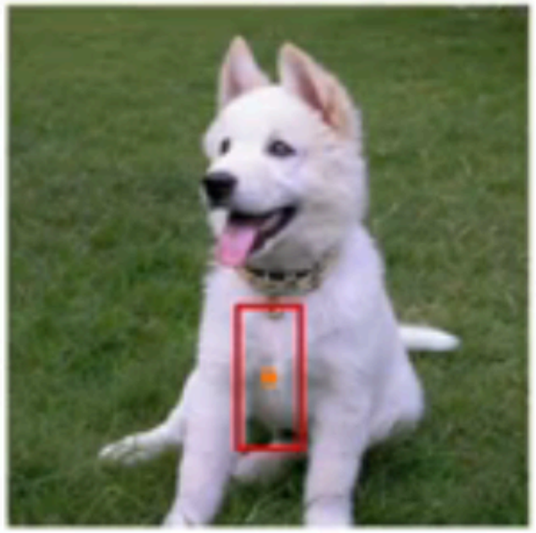
ANCHOR POINTS

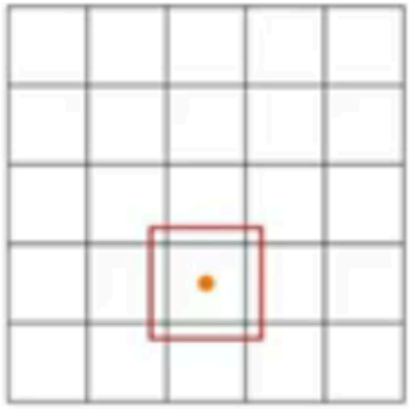


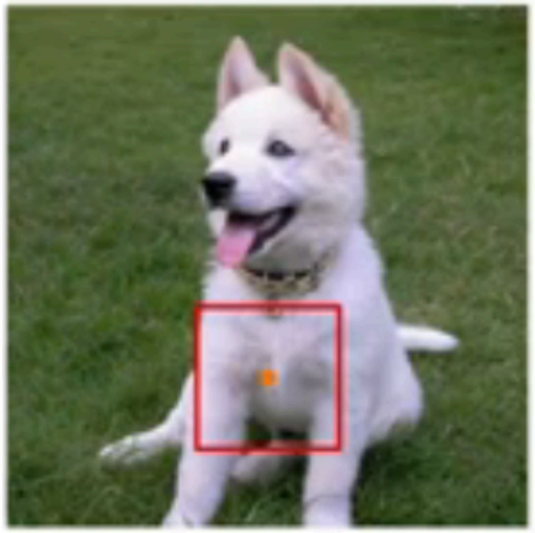
ANCHOR BOXES

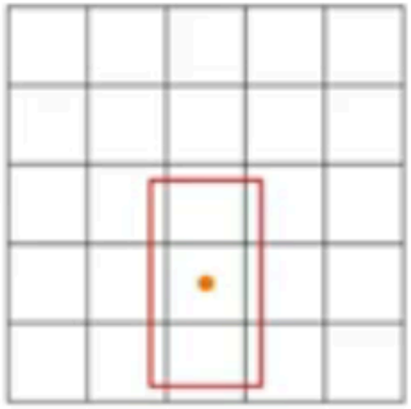


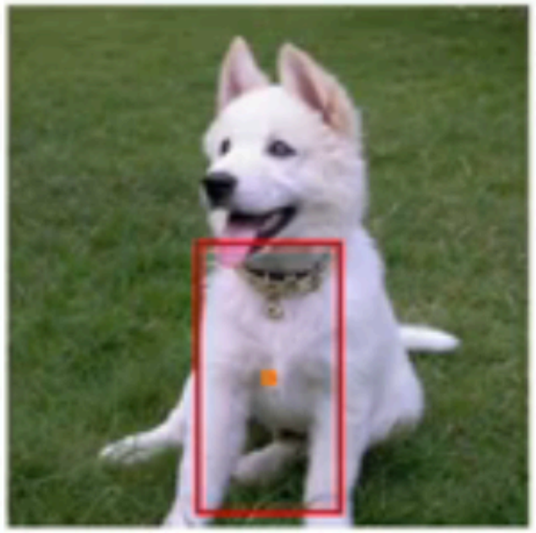




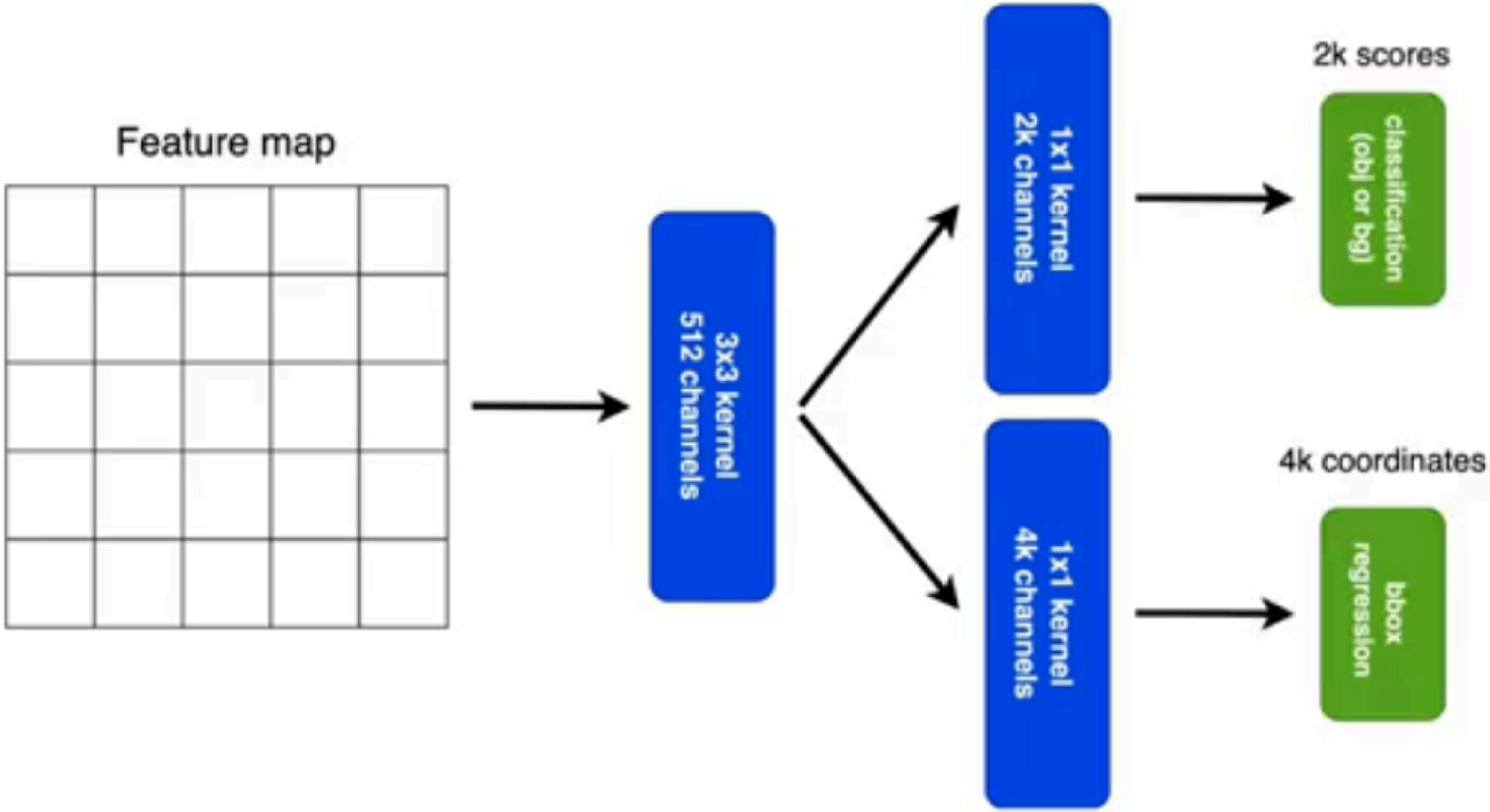




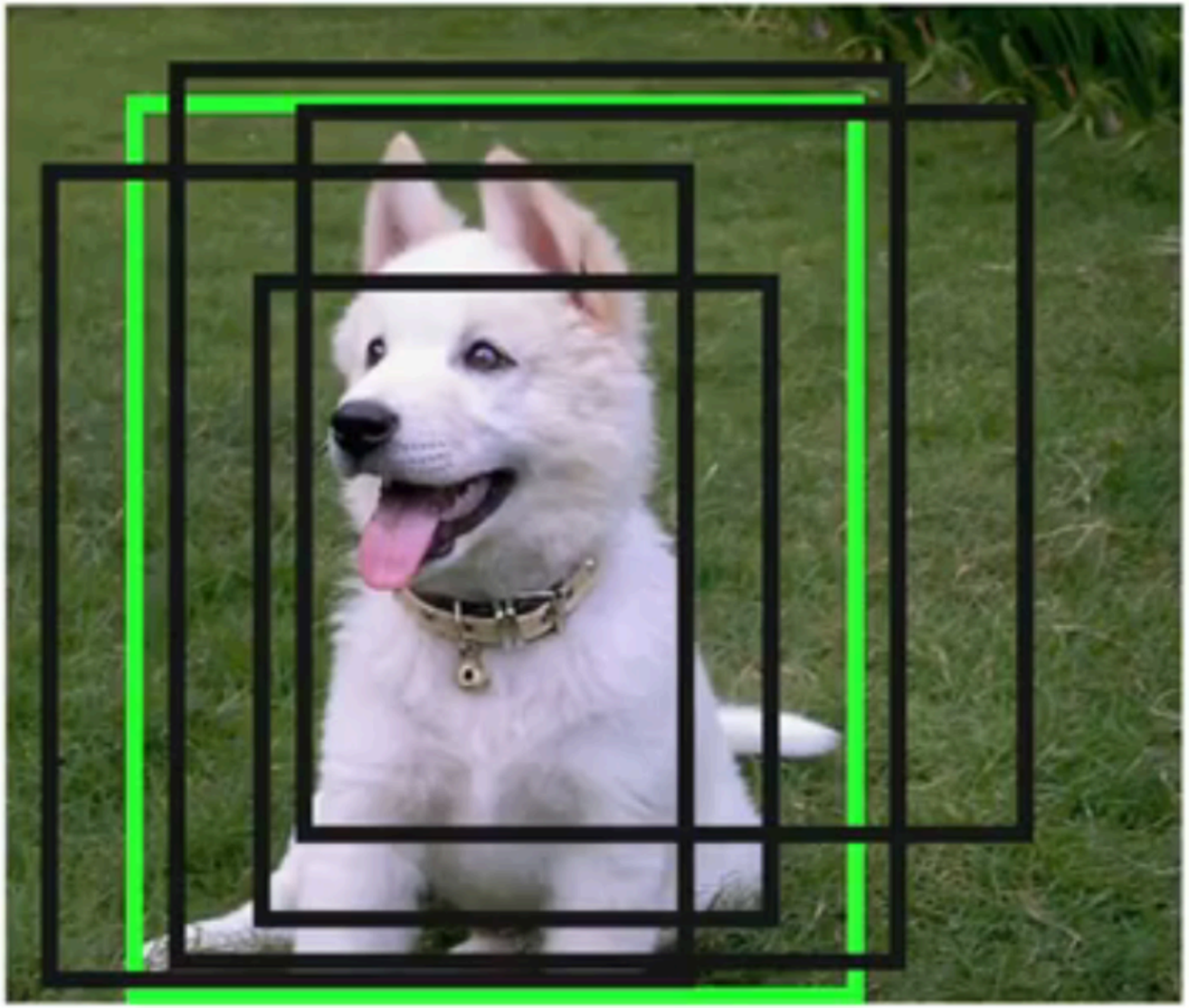




REGION PROPOSAL NETWORK

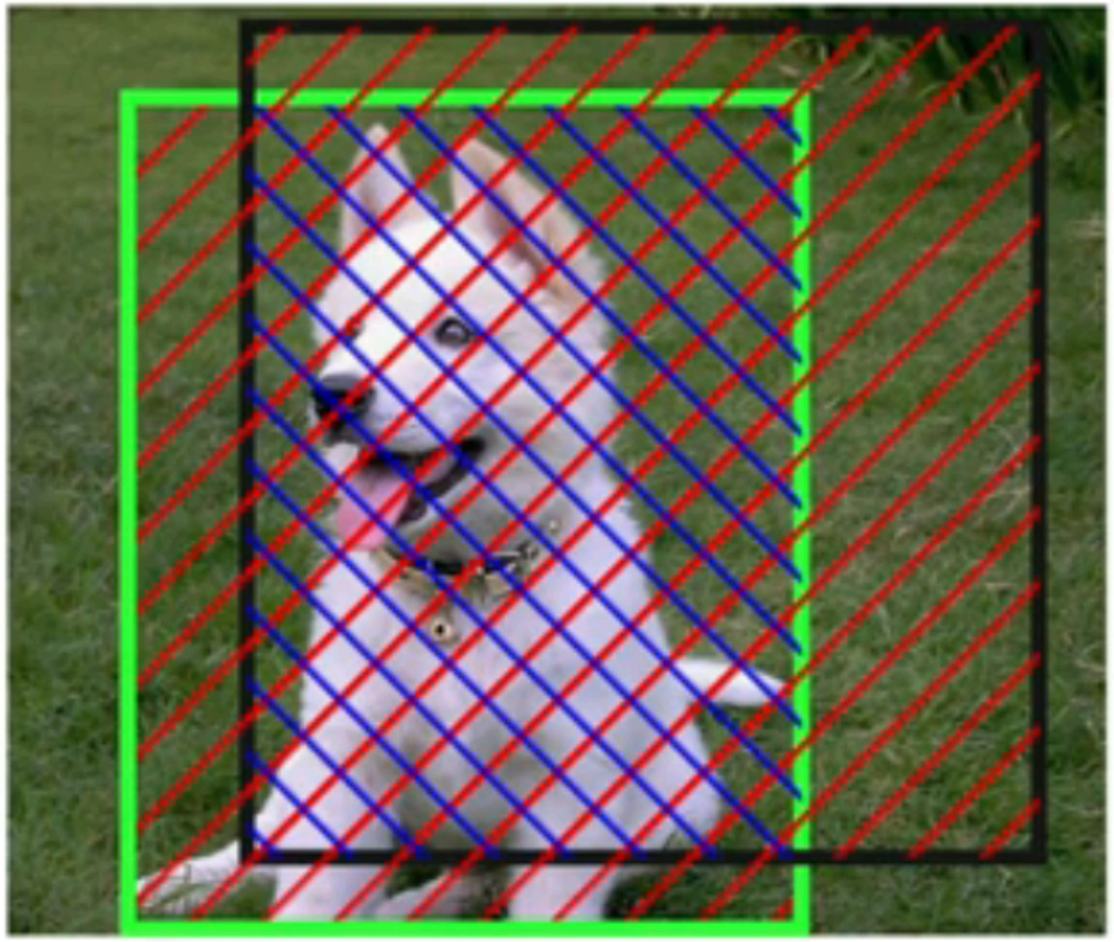


WHICH BOX TO USE?



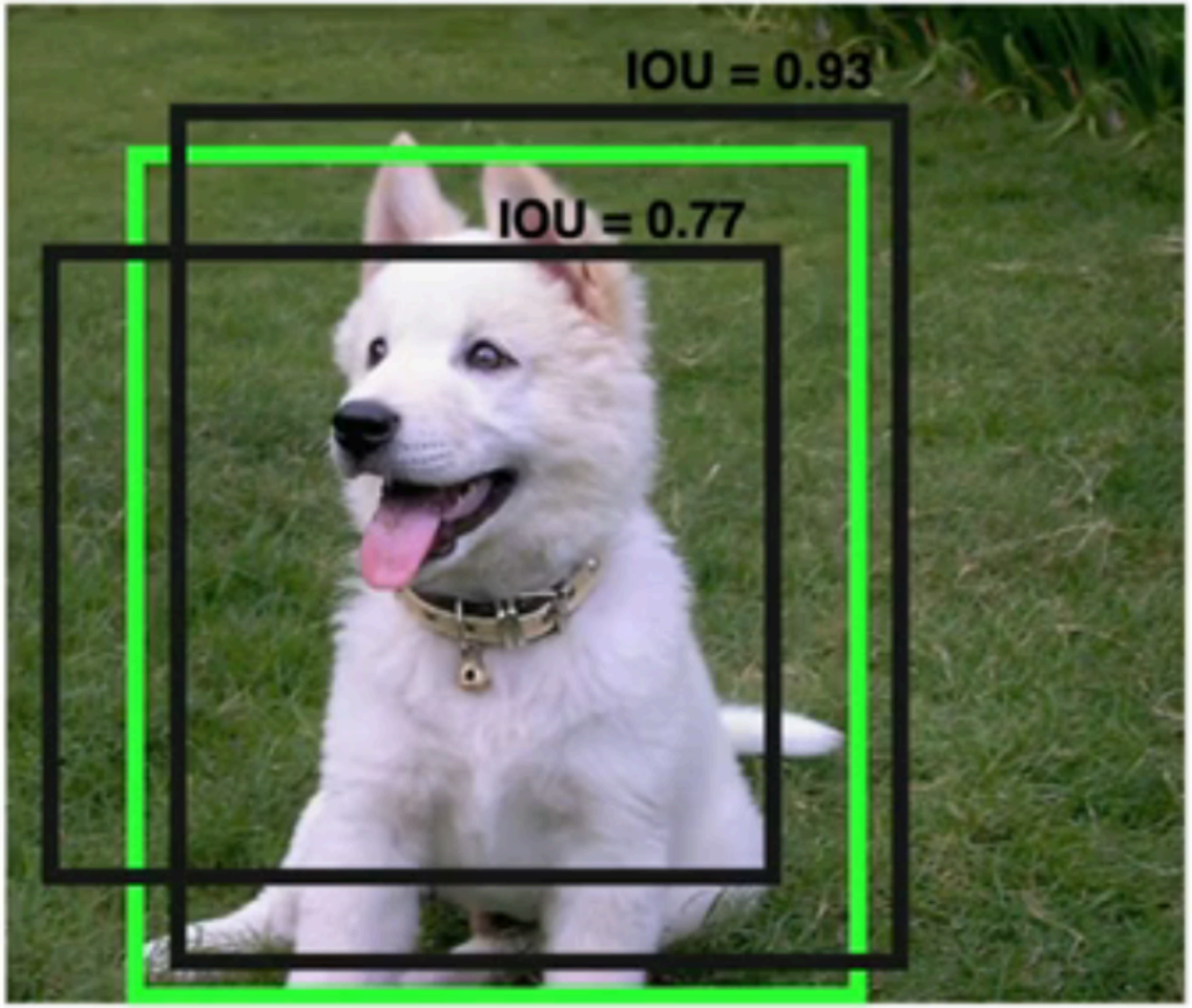
Which anchor bounding box to use for a specific object during training?

INTERSECTION OVER UNION

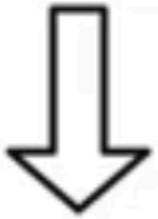


$$IOU = \frac{\text{intersection}}{\text{union}}$$

INTERSECTION OVER UNION

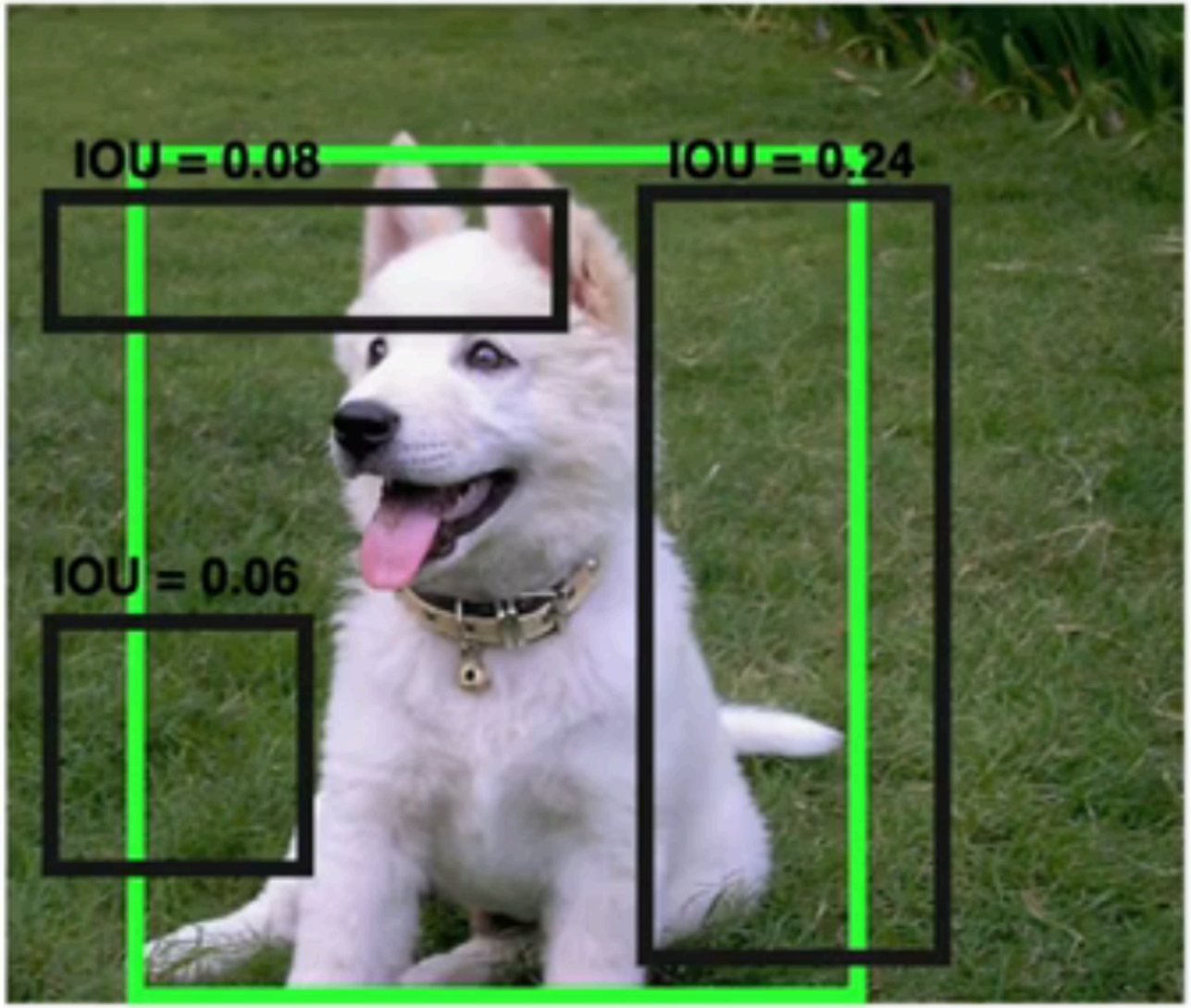


IoU > 0.7

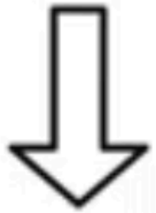


positive

INTERSECTION OVER UNION

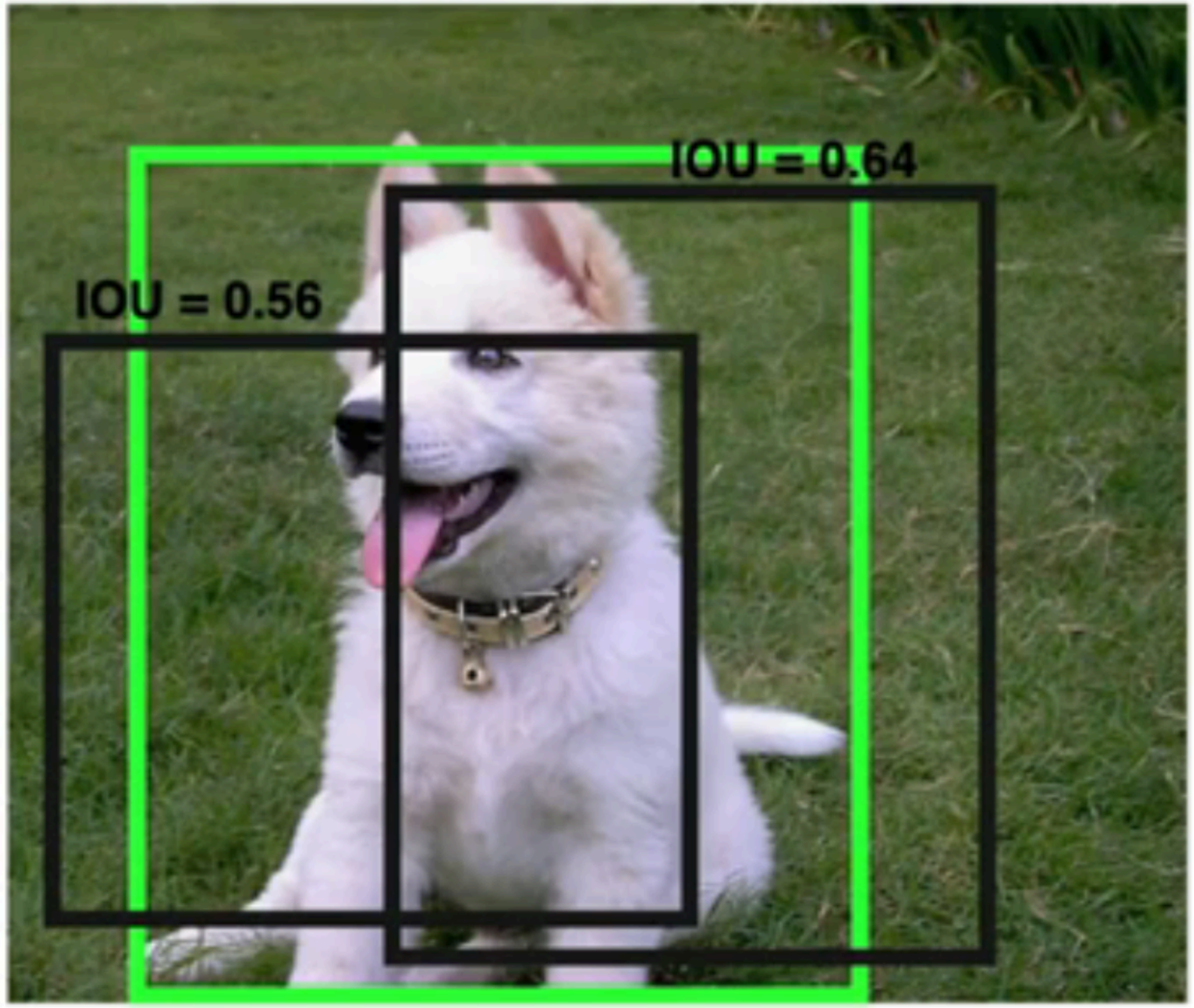


IoU < 0.3



negative

INTERSECTION OVER UNION



$0.5 < \text{IoU} \leq 0.7$

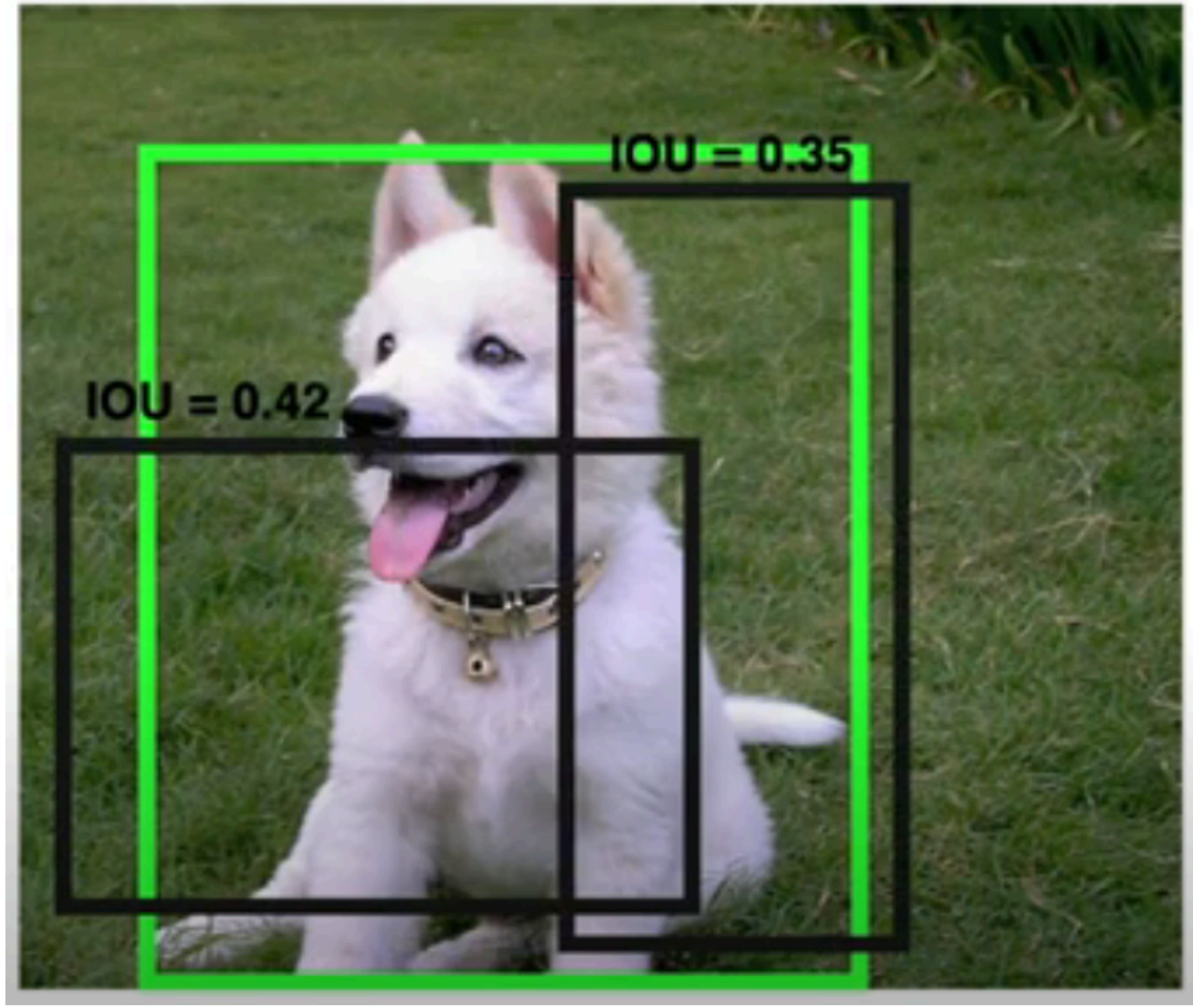
+

no IoU > 0.7

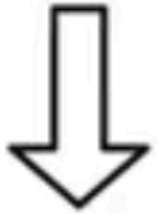
↓

highest one positive

INTERSECTION OVER UNION



$0.3 \leq IoU \leq 0.5$



not positive
not negative

THEN WHY DOES YOLO EXIST?

RCNN

- Simple and scalable.
- improves mAP.

- A multistage pipeline.
- Training is expensive in space and time (features are extracted from each region proposal in each image and written into disk).
- Object detection is slow.

Fast-RCNN

- Higher mAP.
- Single stage, end-to-end training.
- No disk storage is required for feature caching.

- proposals are the computational bottleneck in detection systems.

Faster-RCNN

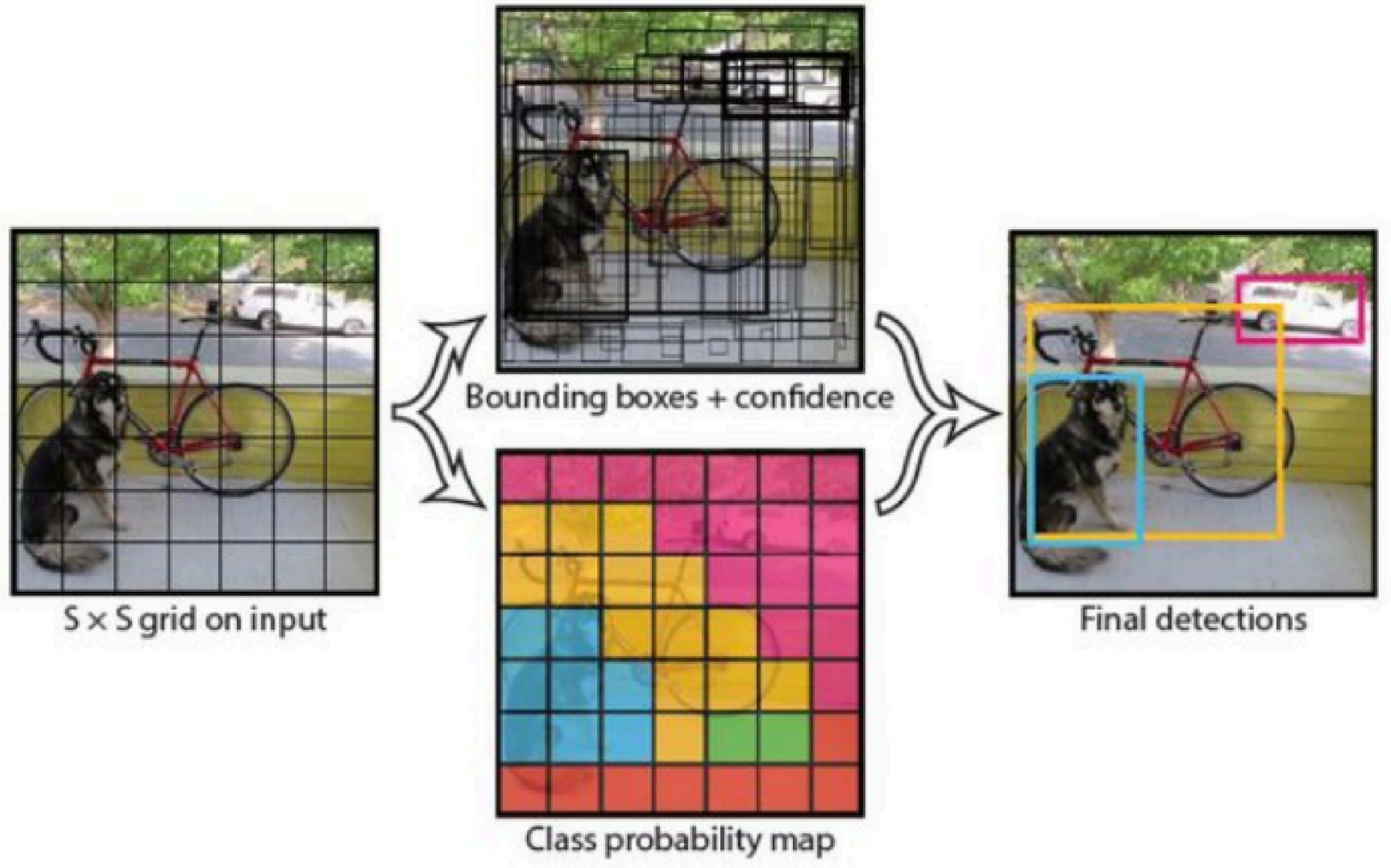
- compute proposals with a deep convolutional neural network --*Region Proposal Network* (RPN)
- merge RPN and Fast R-CNN into a single network, enabling nearly cost-free region proposals.

?

YOLO (YOU ONLY LOOK ONCE)

Idea: No bounding box proposal. A single regression problem, straight from image pixels to bounding box coordinates and class probabilities.

- Extremely fast
- Learns generalizable representations.



HANDS ON / CHALLENGE TASK

Task 1: In this task, you will use the provided Fast RCNN and Faster RCNN models to perform object detection on any object detection dataset of your choice. You are expected to fit the dataloaders, train both models, and evaluate their performance.

Dataset: any object detection dataset (Pascal VOC subset, COCO subset, etc)
Metrics: use mean average precision (mAP), inference time, and accuracy.

Reference code for Fast RCNN and Faster RCNN:
https://colab.research.google.com/drive/1E18GeirhjNQrVb_04en5ot_ch4ziH259?usp=sharing