Object Detection and Faster RCNN

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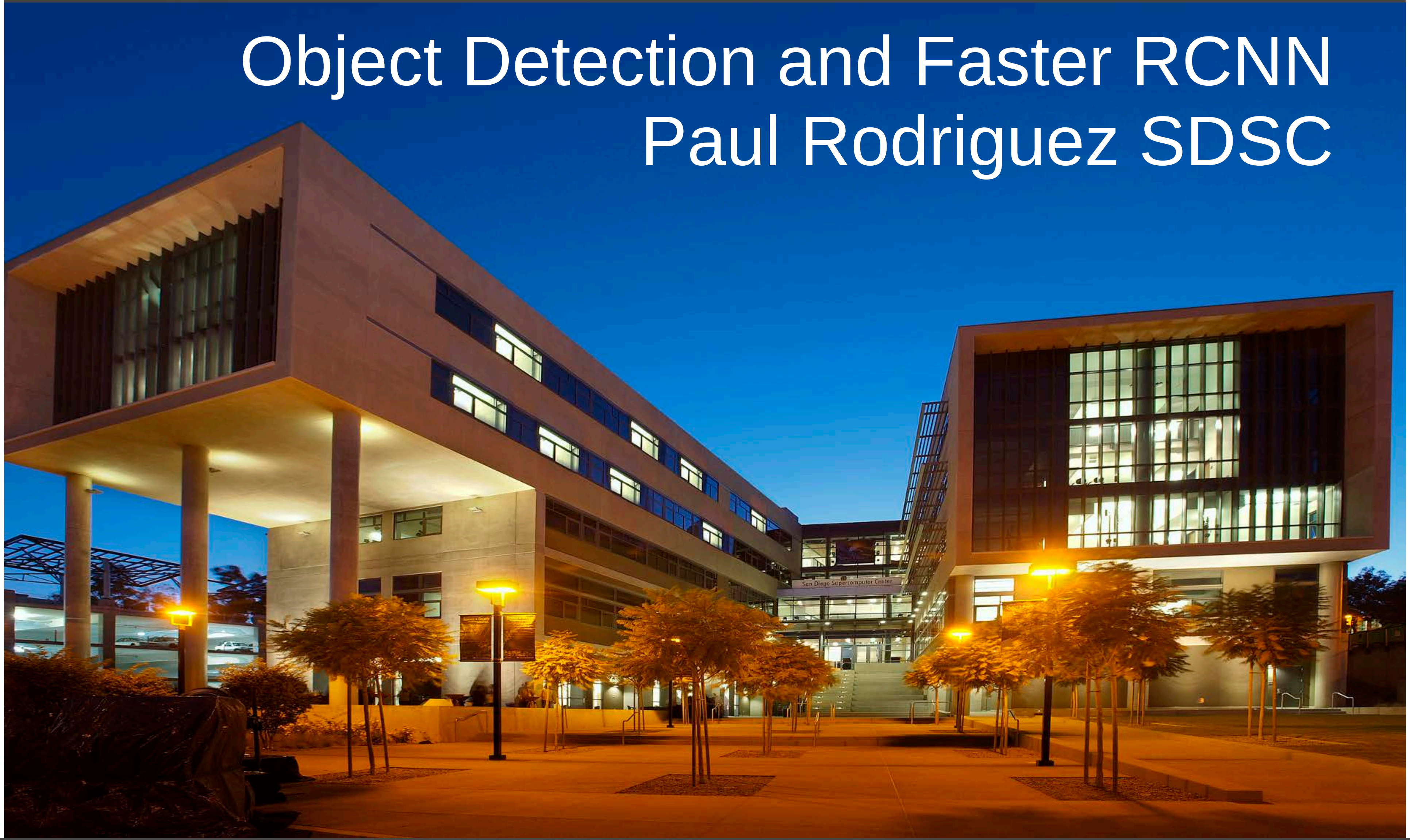
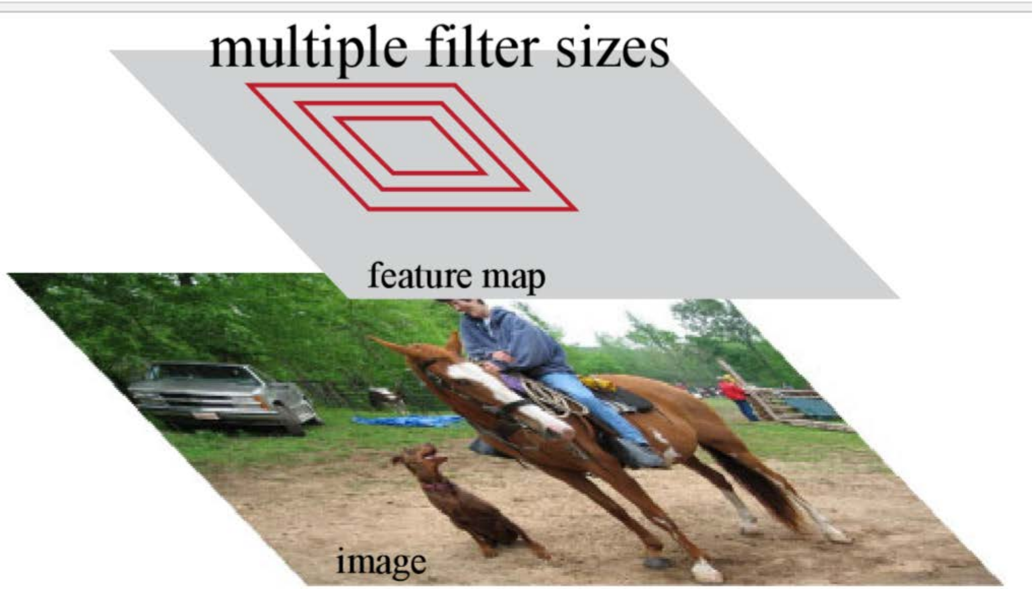
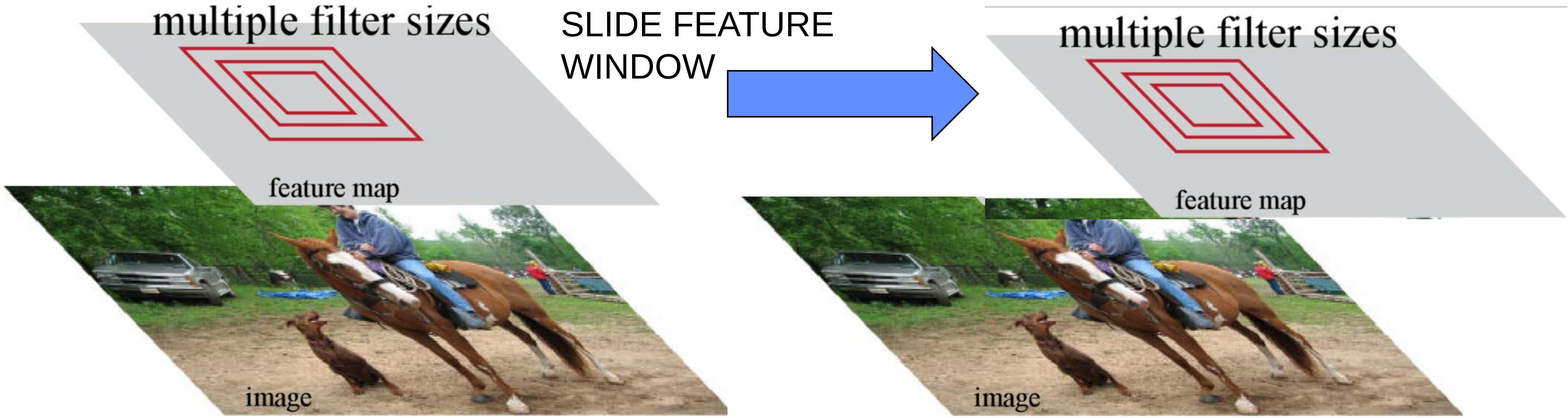


How to find object instances of different sizes across images?

Combination of image resizing, different filter sizes, and sliding windows helps find objects



Combination of image resizing, different filter sizes, and sliding windows helps find objects

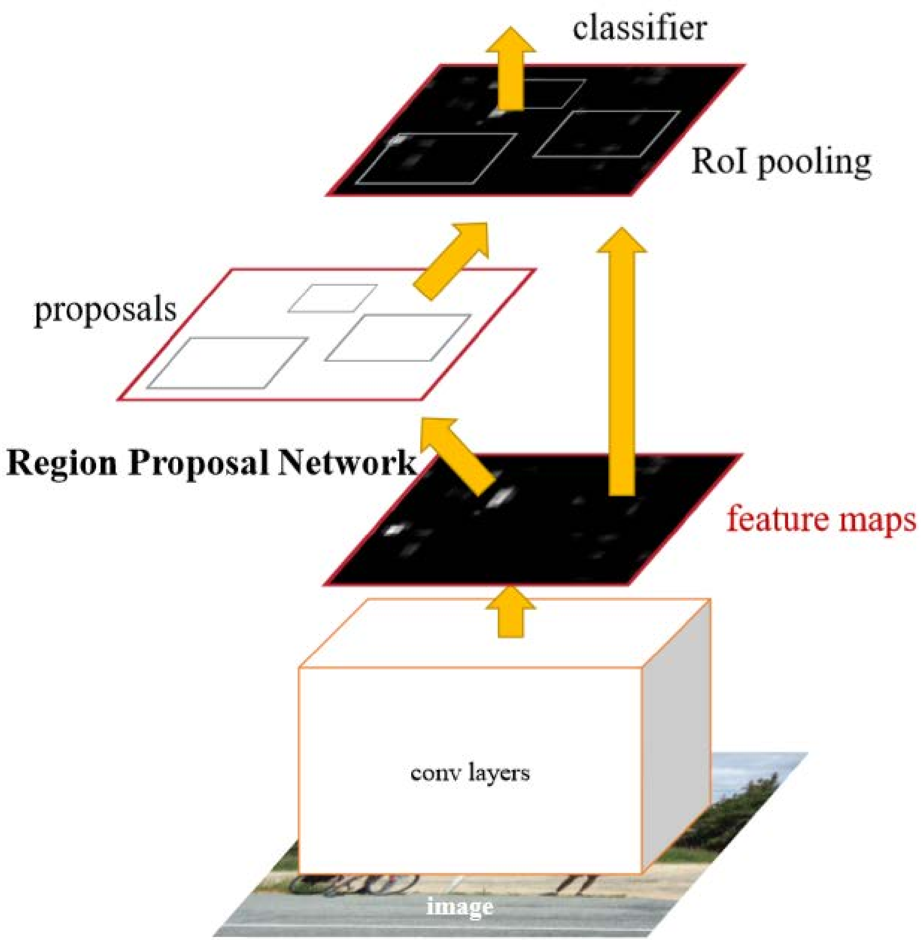


SLIDE FEATURE
WINDOW

Or, use CNN to classify and detect: Faster RCNN

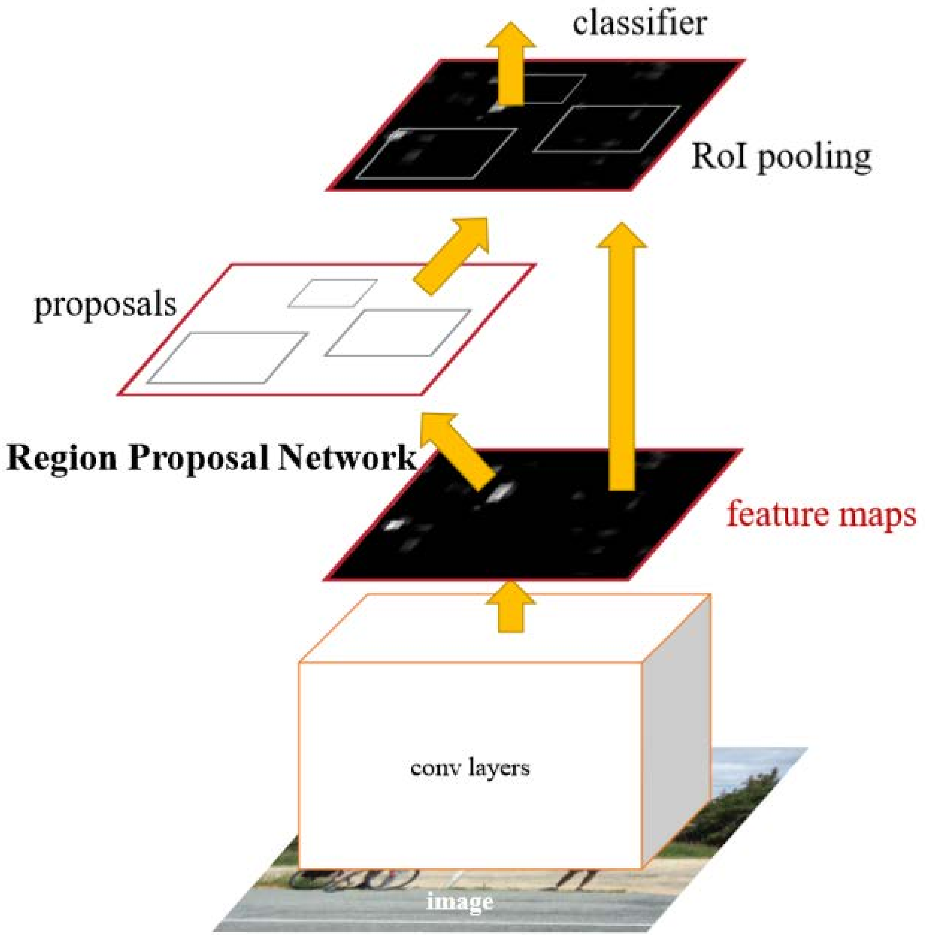
(Ren,He,Girschick,Sun)

A side path to select Regions



Or, use CNN to classify and detect: Faster RCNN

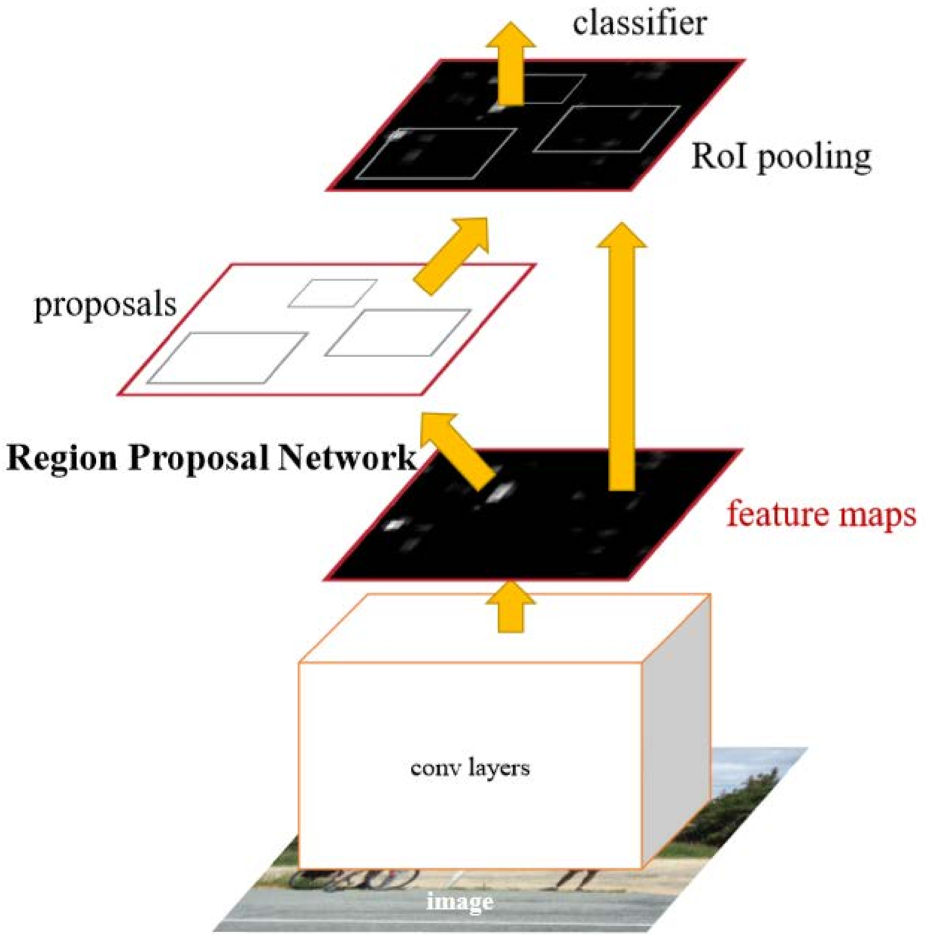
(Ren,He,Girschick,Sun)



Images are normalized and resized

Or, use CNN to classify and detect: Faster RCNN

(Ren,He,Girschick,Sun)



Pool with adjustable windows to transform into one size vector for classification

Images are normalized and resized

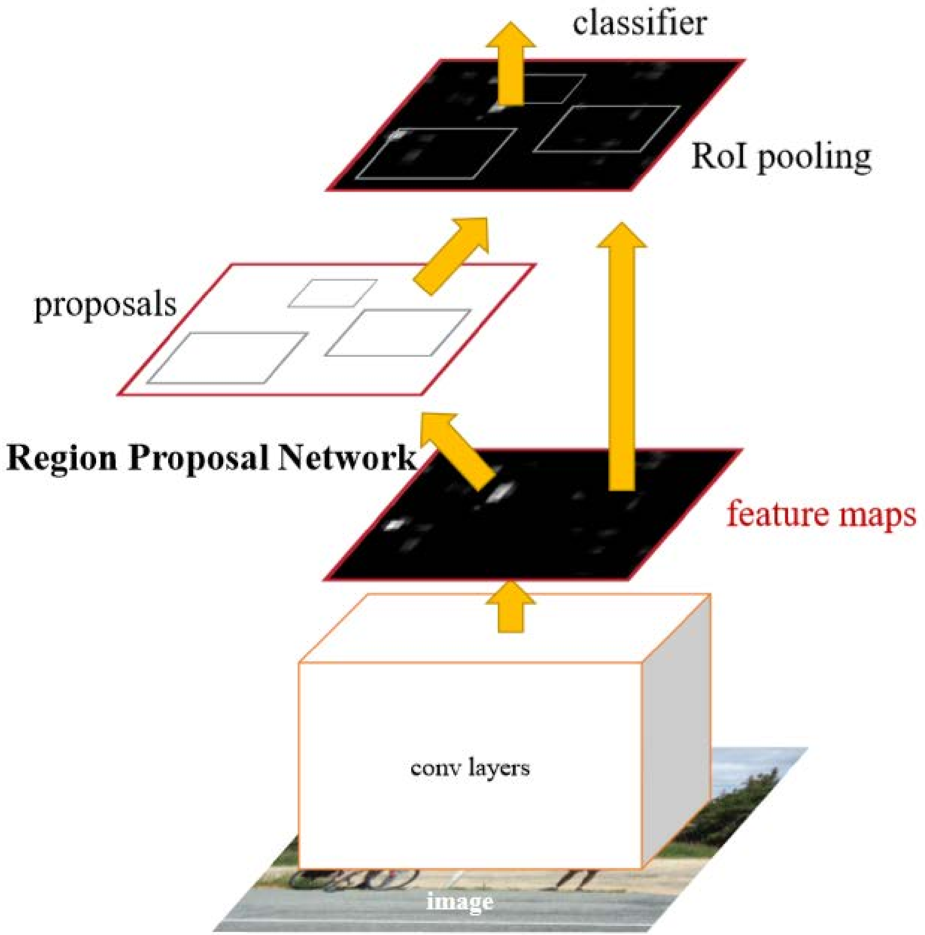
Or, use CNN to classify and detect: Faster RCNN

(Ren,He,Girschick,Sun)

1. *Start with 2000 sampled regions; segment, group, get texture of possible foreground regions*

2. *Then use feature map values and a model to predict if an object (of any class) would be detected in each window.*

3. *Pass maps for best regions to classifier*



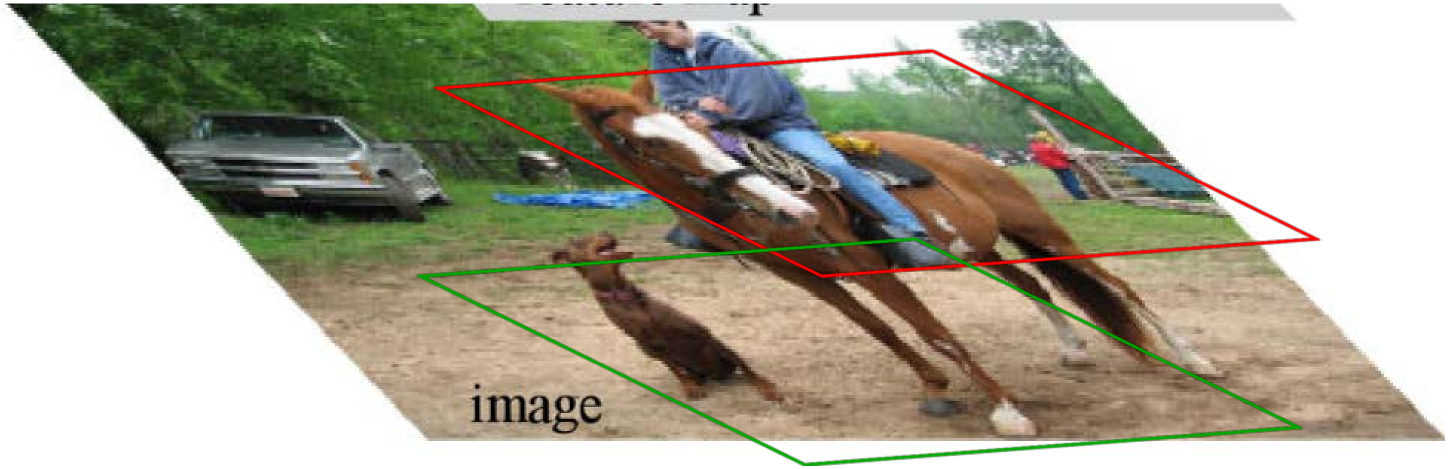
Pool with adjustable windows to transform into one size vector for classification

Images are normalized and resized

Training Data

- **Given positive sample, generate negative samples**

  (and balance sample sizes)



Sample and add boxes with < 40% overlap as ‘negative’, > 50% as positive

Training Data

- Given positive sample, generate negative samples

(and balance numbers)

Train region proposal and classifier alternatively in 4 phases

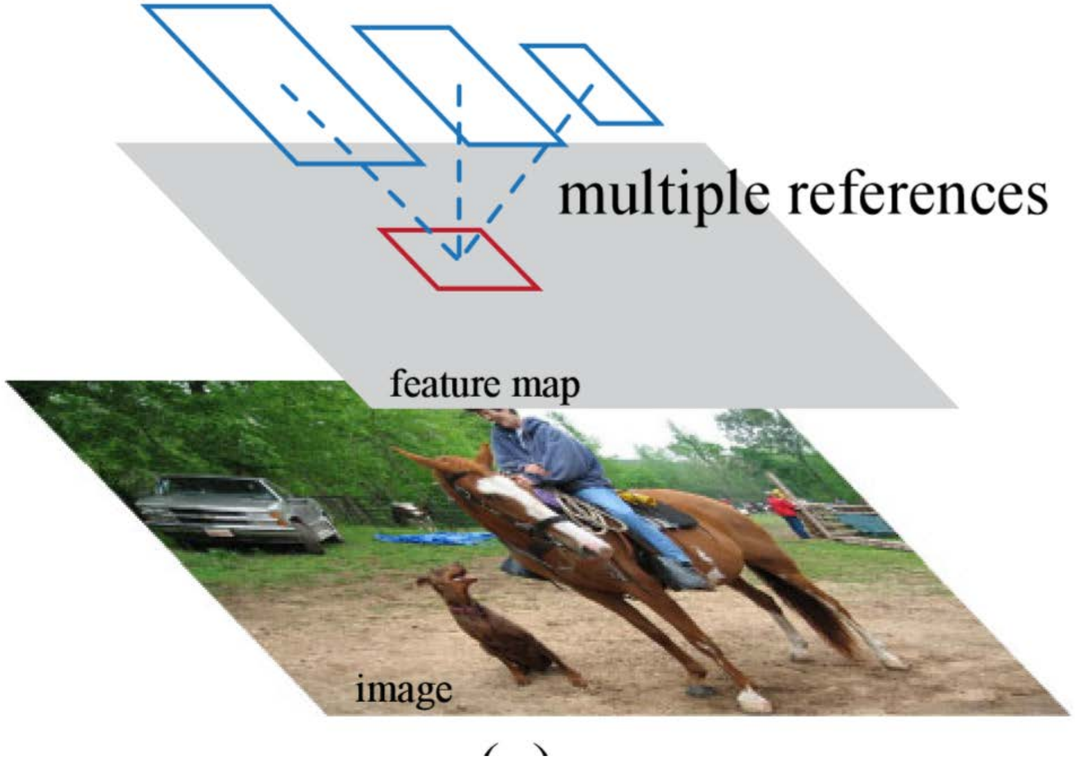
Phases:

1,3 region proposal

2,4 classification

Region output

- **Output bounding box information (box center, height, width)**



Region Box size ranges

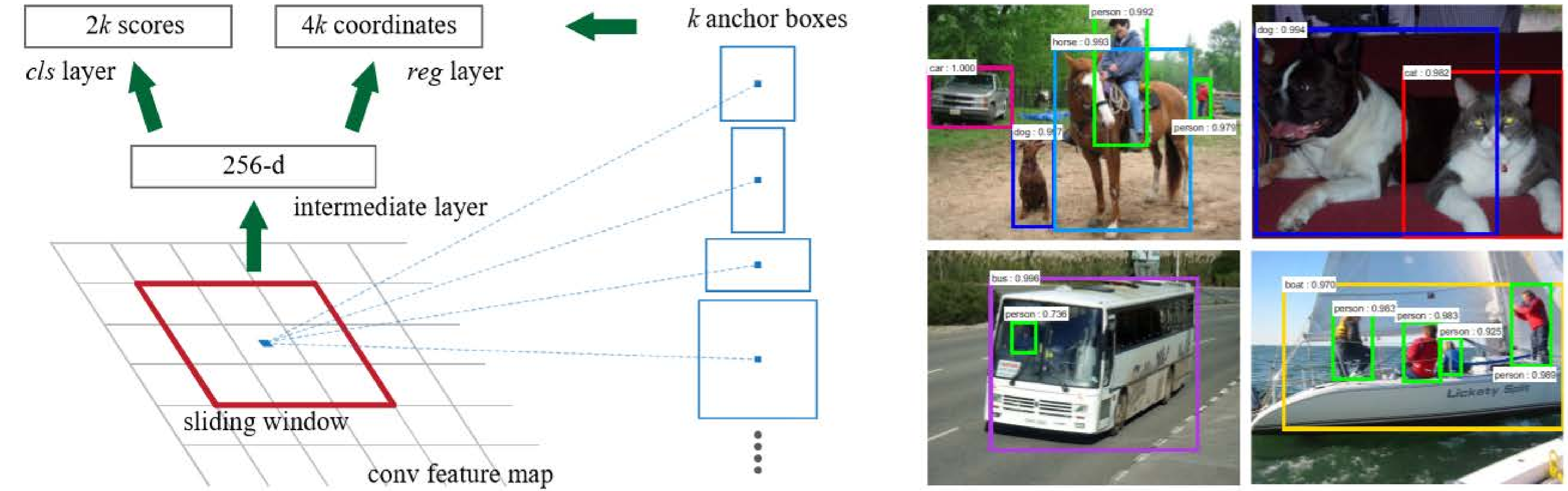


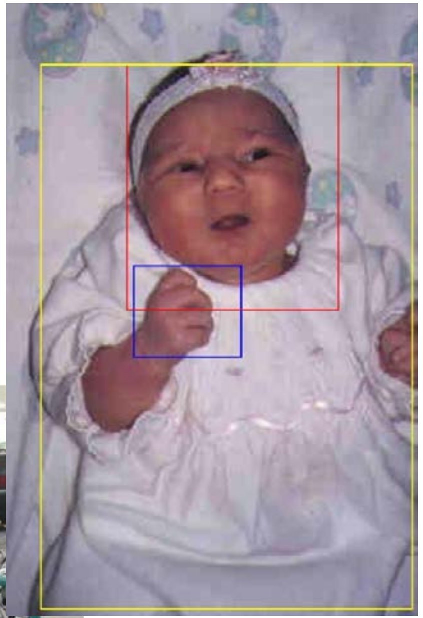
Figure 3: **Left**: Region Proposal Network (RPN). **Right**: Example detections using RPN proposals on PASCAL VOC 2007 test. Our method detects objects in a wide range of scales and aspect ratios.

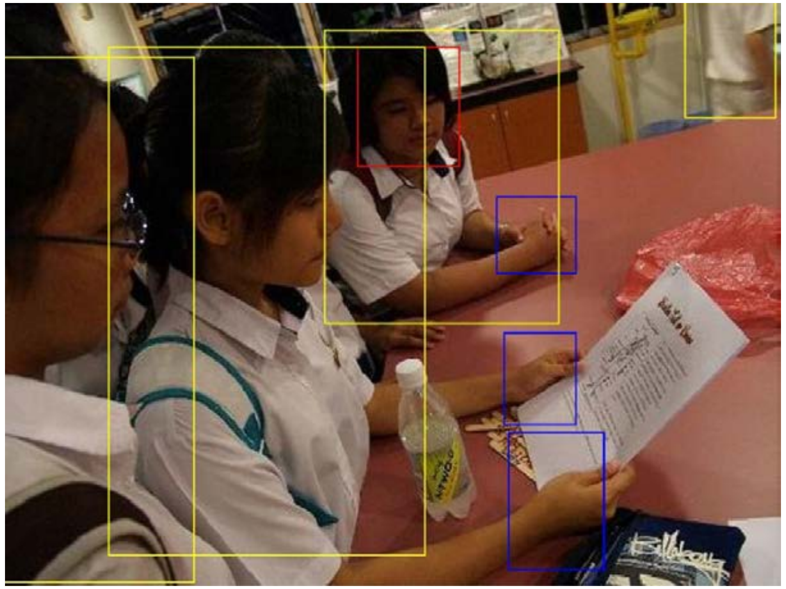
Samples of ‘hand’ training data

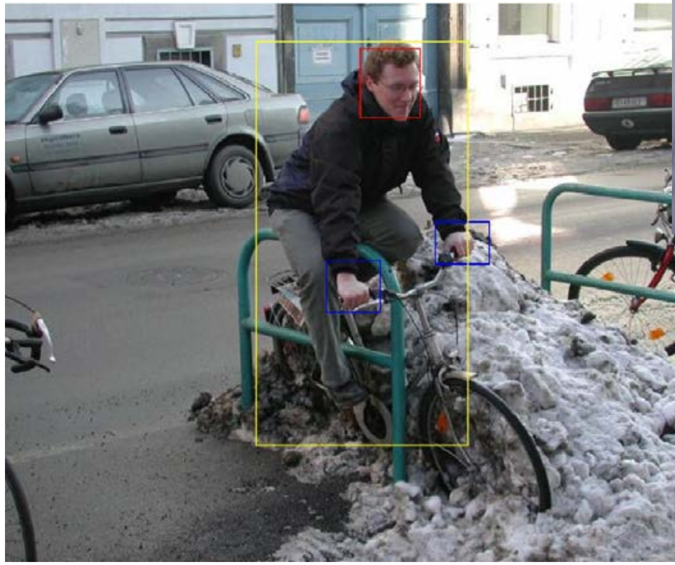
Person boxes (using YOLO in ‘darknet’ code)

Face detection using ‘DLIB’ library

Hand boxes were hand drawn(Mittal etal.)







Matlab Implementation

```
detector = trainFasterRCNNObjectDetector(
                          trainingData, layers, options, ...
```

Table of ~4K image file names and ~8K boxes

A defined set of layers

learning rate, epochs
.0001   phase1,2
.00001 phase 3,4
15 epochs

Matlab Implementation

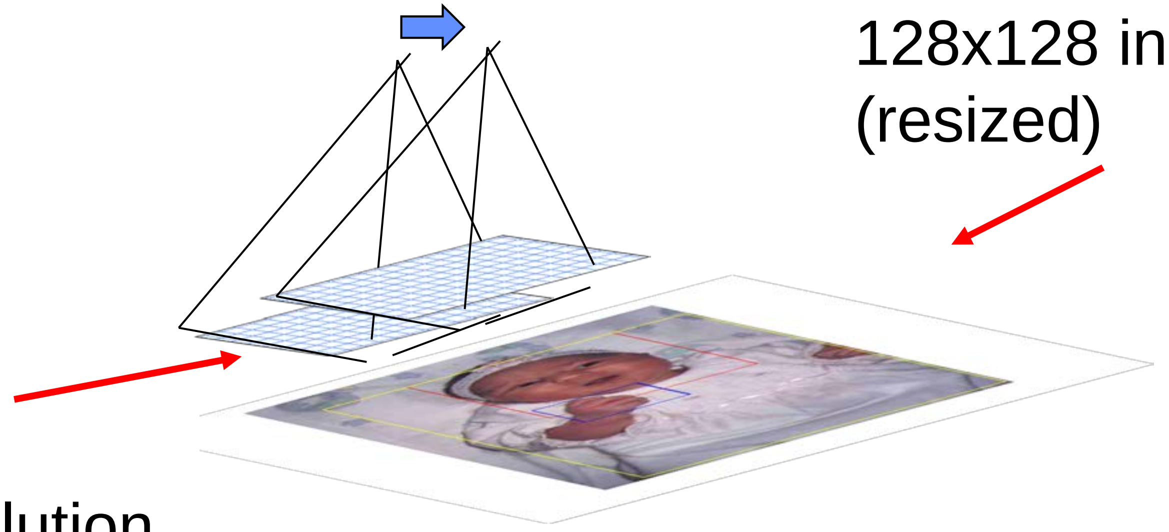
```
detector = trainFasterRCNNObjectDetector(
                                   trainingData, layers, options, ...
      'NegativeOverlapRange', [0.1 0.4], ...
      'PositiveOverlapRange', [0.6 1], ...
      'NumStrongestRegions',200,…
      'BoxPyramidScale',1.2,...
      'NumBoxPyramidLevels',5);
```

For making pos/neg samples

For selecting object (anchor) boxes

Matlab Faster RCNN

- **My parameters:**



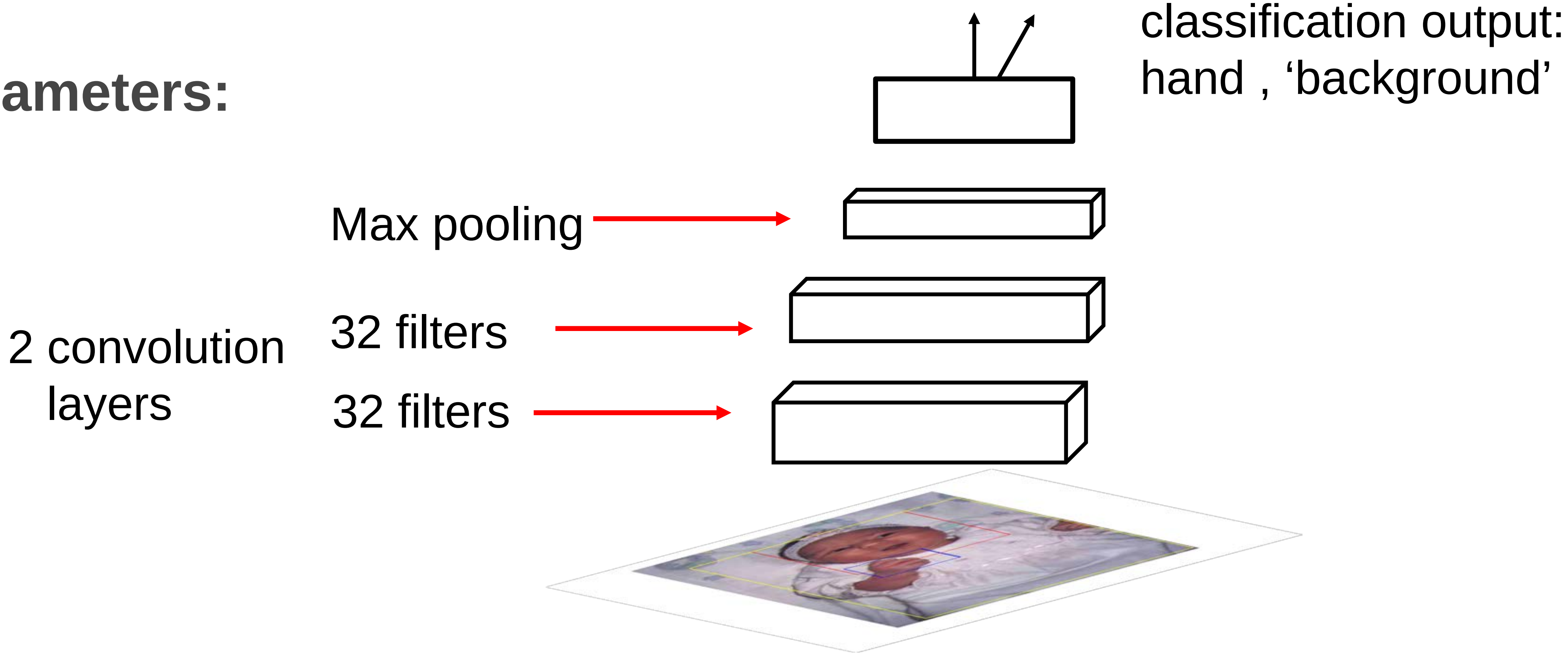
stride=2

128x128 input (resized)

5x5 convolution

Matlab Faster RCNN

- **My parameters:**

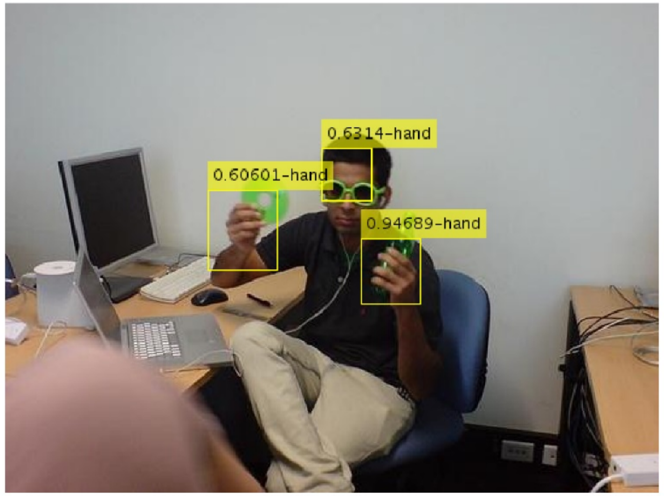


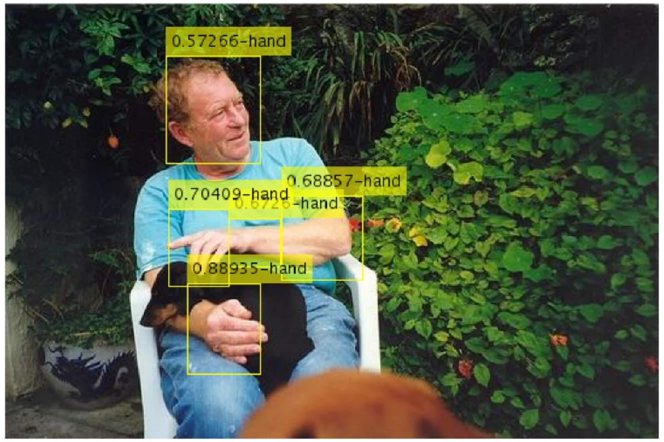
Network detail

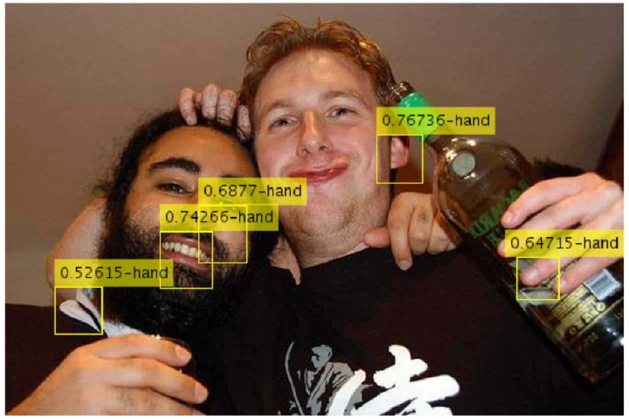
```
>>  detector.Network.Layers

11x1 Layer array with layers:

    1   'imageinput'         Image Input            128x128x3 images with 'zerocenter' normalization
    2   'conv_1'             Convolution            32 5x5x3 convolutions with stride [2  2] and padding [1  1  1  1]
    3   'relu_1'             ReLU                   ReLU
    4   'conv_2'             Convolution            32 5x5x32 convolutions with stride [2  2] and padding [1  1  1  1]
    5   'relu_2'             ReLU                   ReLU
    6   'roi pooling layer'   ROI Max Pooling       ROI Max Pooling with grid size [14 14]
    7   'fc_1'               Fully Connected        32 fully connected layer
    8   'relu_3'             ReLU                   ReLU
    9   'fc_2'               Fully Connected        2 fully connected layer
   10   'softmax'            Softmax                softmax
   11   'classoutput'        Classification Output   crossentropyex with classes 'hand' and 'Background'
```

Results (so far)

- Using 50% overlap with true box as correct ~25% TP rate
- 4-8 hours on 1 compute node (CPU) 15 epochs ~4K images







Matlab Implementation

```
detector = trainFasterRCNNObjectDetector(
                              trainingData, vgg19, options, ...
```

Table of ~1K image file names and ~2K boxes

A pretrained network from Vis. Geom. Group at Oxford

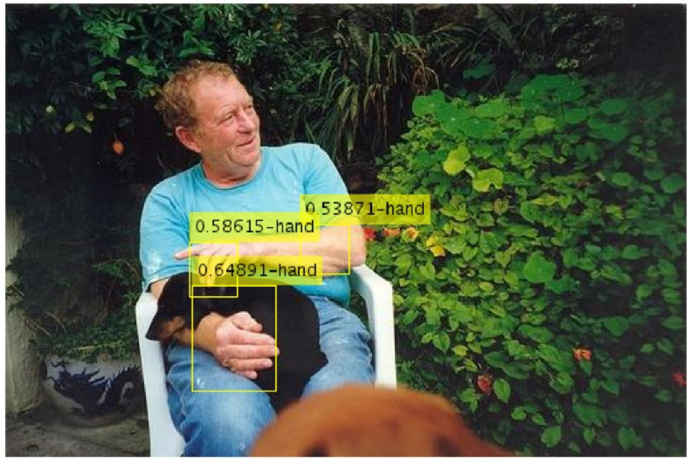
learning rate, epochs
.00001   phase1,2
.000001 phase 3,4
5 epochs

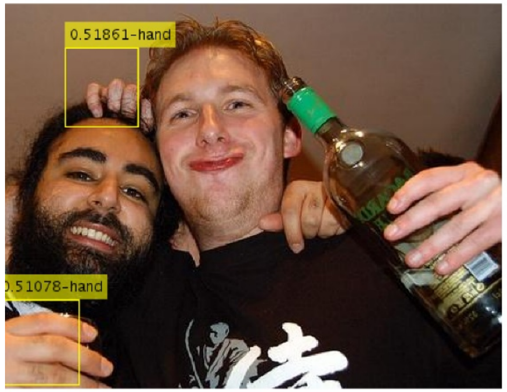
Using VGG19 network

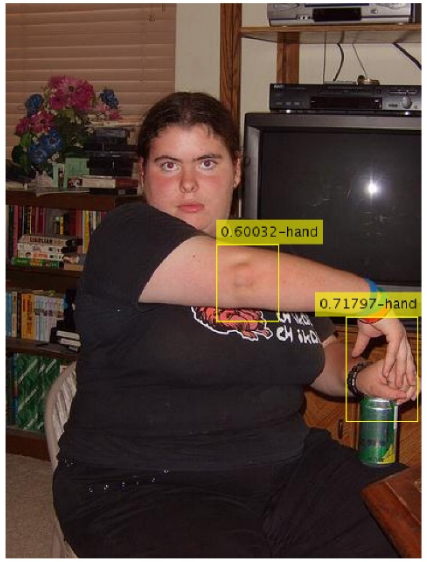
```
detector.Network.Layers(1:7)
 1   'input'     Image Input   224x224x3 images with 'zerocenter' normalization
   2  'conv1_1'   Convolution   64 3x3x3 convolutions with stride [1  1] and padding [1  1  1  1]
   3  'relu1_1'   ReLU          ReLU
   4  'conv1_2'   Convolution   64 3x3x64 convolutions with stride [1  1] and padding [1  1  1  1]
   5  'relu1_2'   ReLU          ReLU
   6  'pool1'     Max Pooling   2x2 max pooling with stride [2  2] and padding [0  0  0  0]
   7  'conv2_1'   Convolution   128 3x3x64 convolutions with stride [1  1] and padding [1  1  1  1]
……
detector.Network.Layers(35:47)
   1  'relu5_3'             ReLU                    ReLU
   2  'conv5_4'              Convolution             512 3x3x512 convolutions with stride [1  1] and padding [1  1  1  1]
   3  'relu5_4'             ReLU                    ReLU
   4  'roi pooling layer'   ROI Max Pooling         ROI Max Pooling with grid size [7 7]
   5  'fc6'                 Fully Connected         4096 fully connected layer
   6  'relu6'                ReLU                    ReLU
   7  'drop6'                Dropout                 50% dropout
   8  'fc7'                 Fully Connected         4096 fully connected layer
   9  'relu7'                ReLU                    ReLU
  10   'drop7'               Dropout                 50% dropout
  11   'fc_detection'        Fully Connected         2 fully connected layer
  12   'softmax'             Softmax                 softmax
  13   'classoutput'         Classification Output   crossentropyex with classes 'hand' and 'Background'
```

Results so far

- Using 50% overlap with true box as correct ~50% TP rate
- 4-8 hours on 1 compute node (CPU) 5 epochs on ~1K images







In Summary

faster RCNN get near 60% TP rate

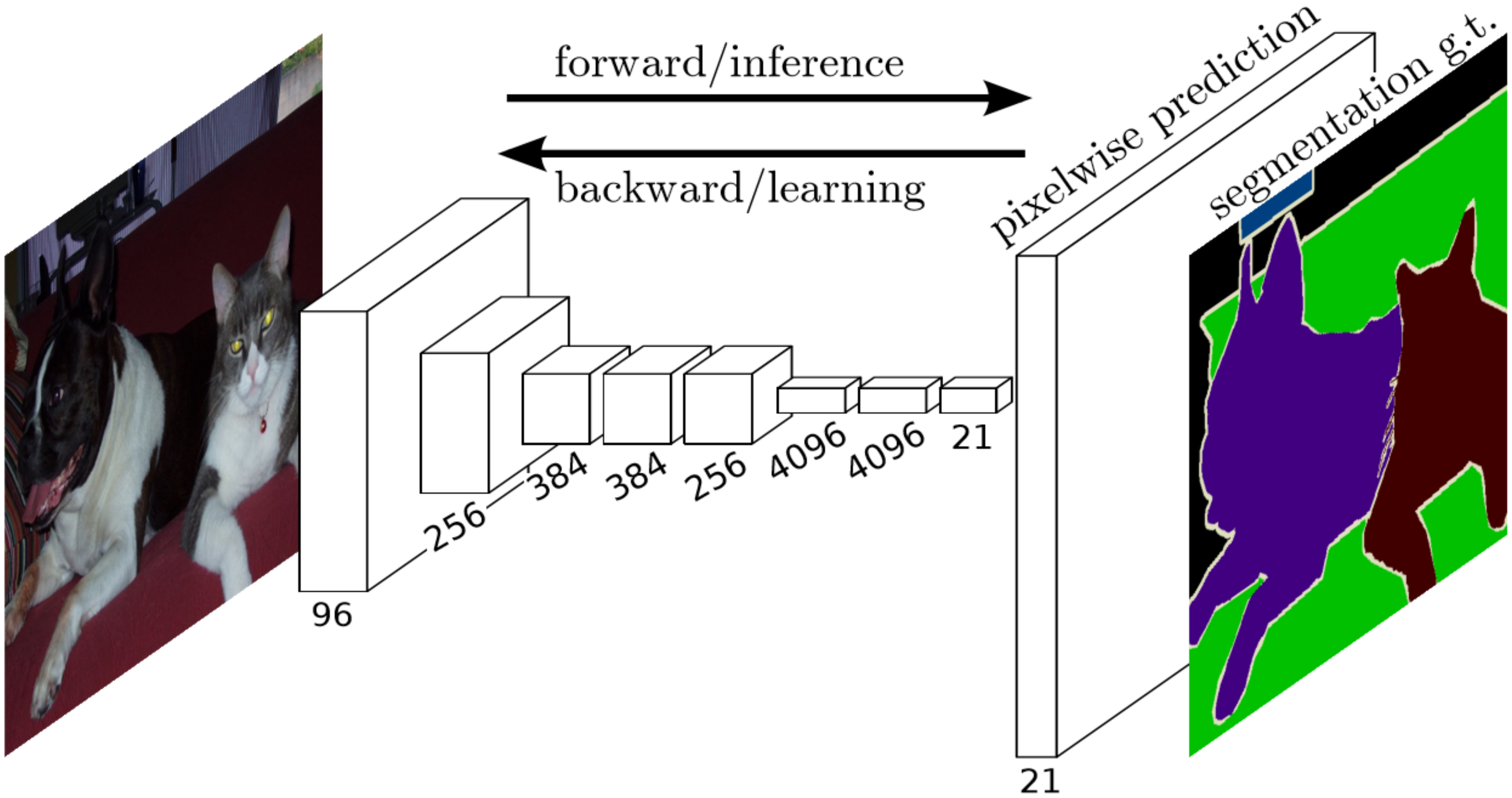
(https://pjreddie.com/media/files/papers/YOLOv3.pdf)

proposing regions takes much time

Matlab fasterRCNN easy to use but could use more options

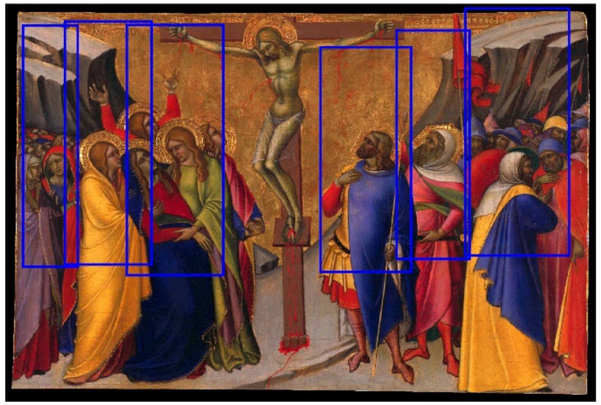
(like turning off weight changes for transfer RCNN learning, reading in images faster, etc..)

Learning Segmentation (deconvolve)

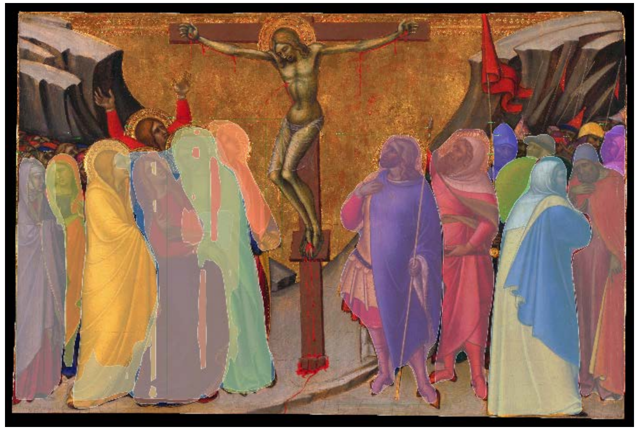


Caffe2, Facebook “Detectron” networks

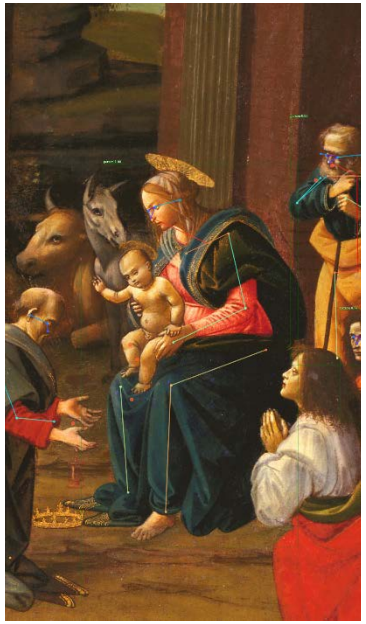
Object Detection
ie getting a region
bounding box
(rcnn)



Object
Segmentation
ie getting a mask
(mask-rcnn)



Object Parts
ie getting keypoints
(keypoint-rcnn)



Caffe2 quick overview

- Facebook took over Caffe, and built Caffe2 on top of pyTorch
- Keras is easier to learn, Caffe2 better for production (supposedly)
- CNNs are built as defined-nets (ie network configurations)
- CNNs are run as prediction-nets
- Network activity directly available as “blobs” (like tensors)
- Caffe2 ‘brew’ library has Keras-like higher level API

Caffe2 Detectron on Comet

- **git clone *https://github.com/facebookresearch/Detectron***

  You will get folders of tools, utilities, etc..

- **On Comet compute node, run:**

```
module purge
module load singularity
singularity shell /share/apps/gpu/singularity/images/pytorch/pytorch-v1.0.0-gpu-20190110.simg
```

Detectron sample execution

“infer_simple” is python program to load and run network and output visualizations

```
python tools/infer_simple.py \
    --cfg configs/12_2017_baselines/e2e_keypoint_rcnn_R-101-
FPN_1x.yaml  \
    --output-dir ./my_output_results \
    --image-ext png \
    --kp-thresh 2 \
    --wts
https://dl.fbaipublicfiles.com/detectron/37697946/12_2017_baselines/
e2e_keypoint_rcnn_R-101-
FPN_1x.yaml.08_45_06.Y14KqbST/output/train/keypoints_coco_201
4_train:keypoints_coco_2014_valminusminival/generalized_rcnn/mod
el_final.pkl \
             my_directory_of_images_to_input
```

A network configuration file; see github site for list - they vary by size, training sets, etc.. and what they output.

Output keypoints above a score (look in utils/vis.py to see how all output details are returned)

Weights for this network

References

- **Book: https://mitpress.mit.edu/books/deep-learning**
- **Documentation: https://keras.io/**
- **Tutorials I used (borrowed):**
  - http://cs231n.github.io/convolutional-networks/
  - https://hackernoon.com/visualizing-parts-of-convolutional-neural-networks-using-keras-and-cats-5cc01b214e59
  - https://github.com/julienr/ipynb_playground/blob/master/keras/convmnist/keras_cnn_mnist.ipynb