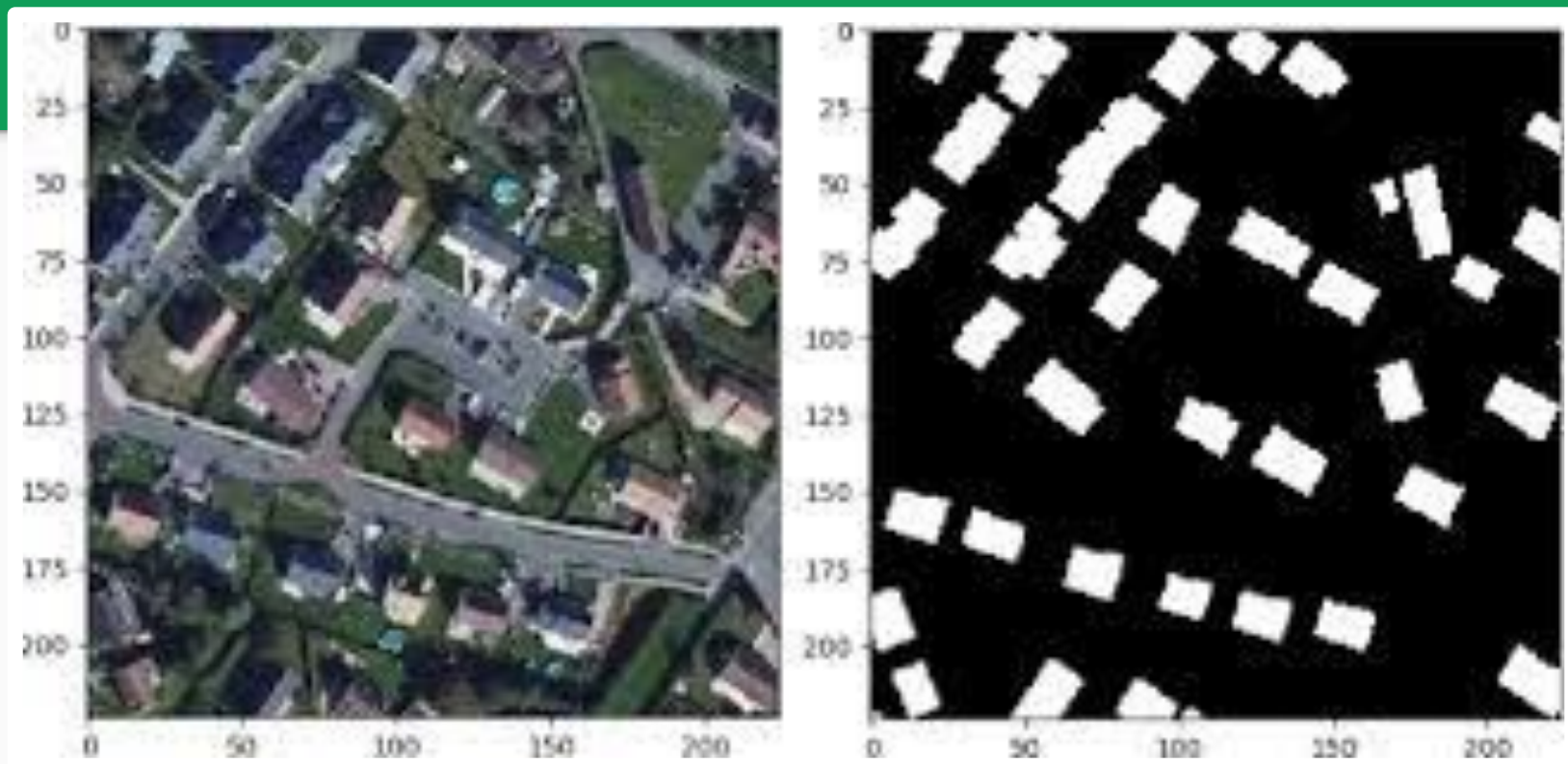# Raster Imagery and Deep Learning
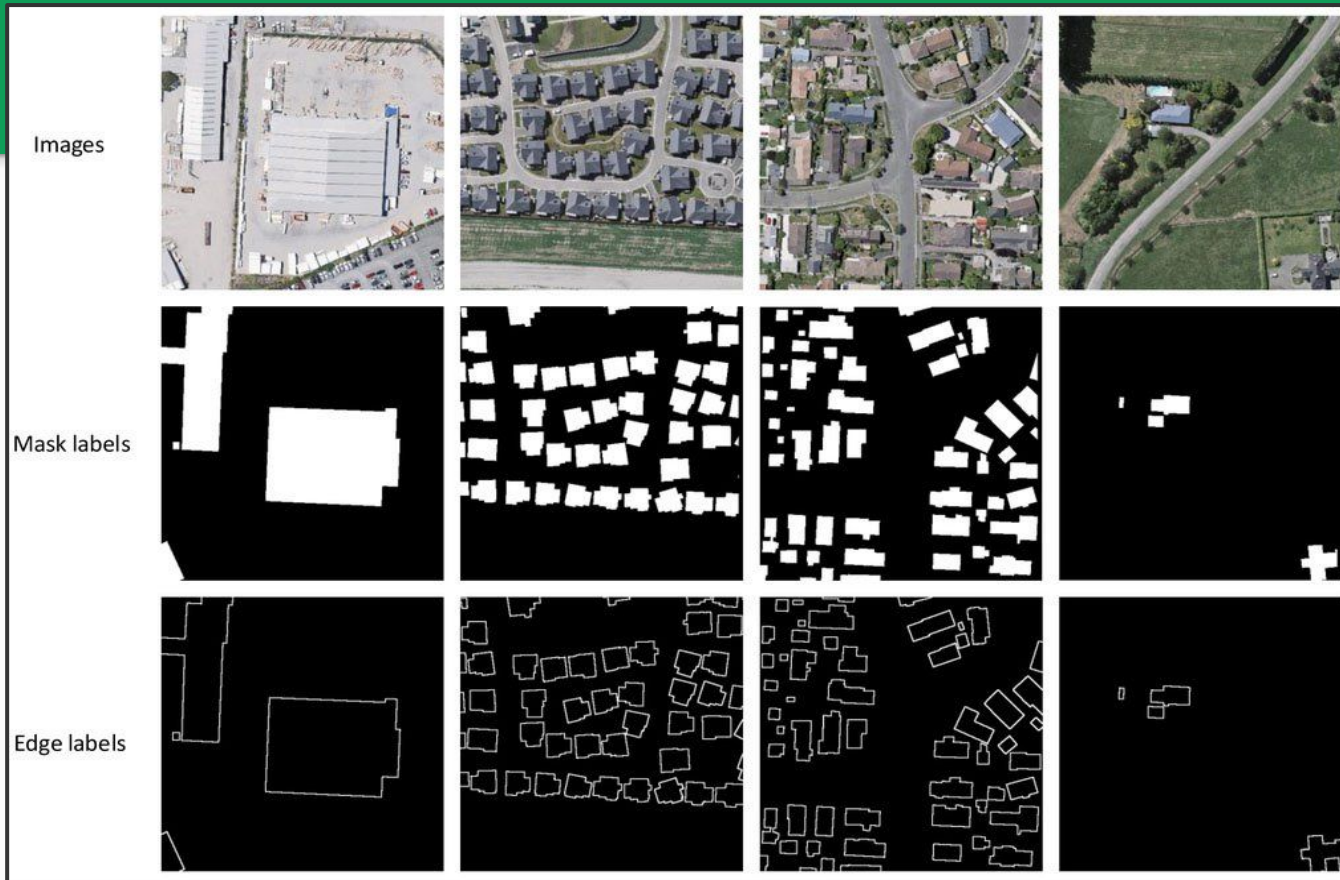
Deep Learning in Remote Sensing

Episode-3

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Building Segmentation

Chhor, Guillaume and Cristian Bartolome Aramburu. "Satellite Image Segmentation for Building Detection using U-net." (2017).
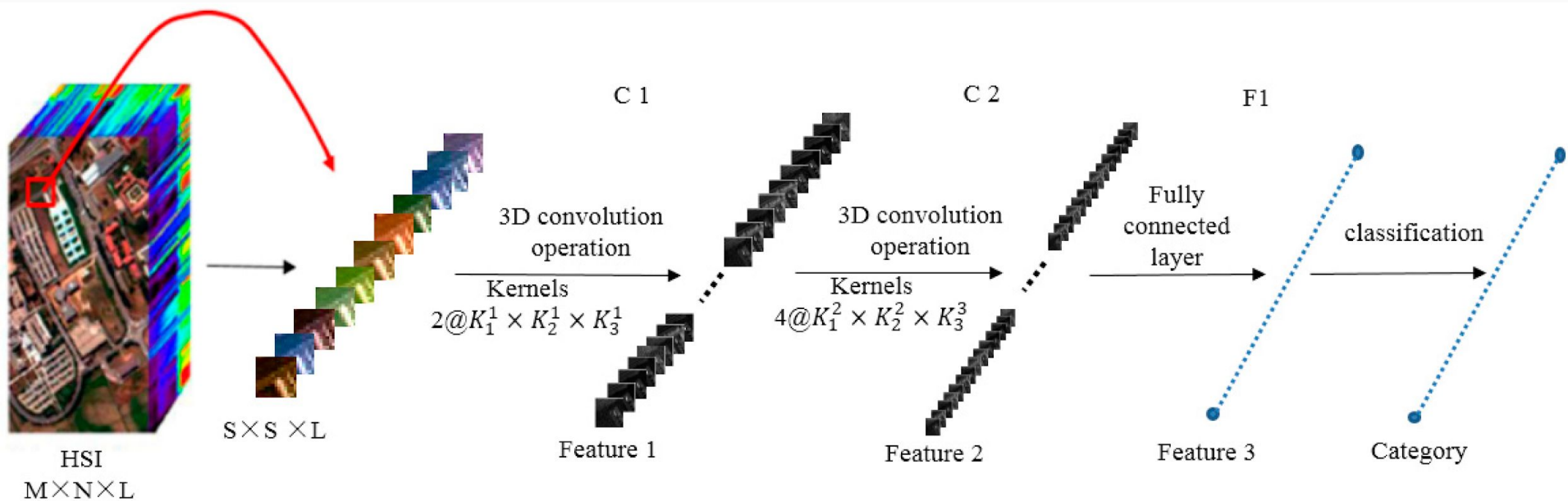
Building Segmentation

Classification of Hyperspectral Data

Hyperspectral data cube: Houston (Texas, USA) – IEEE GRSS
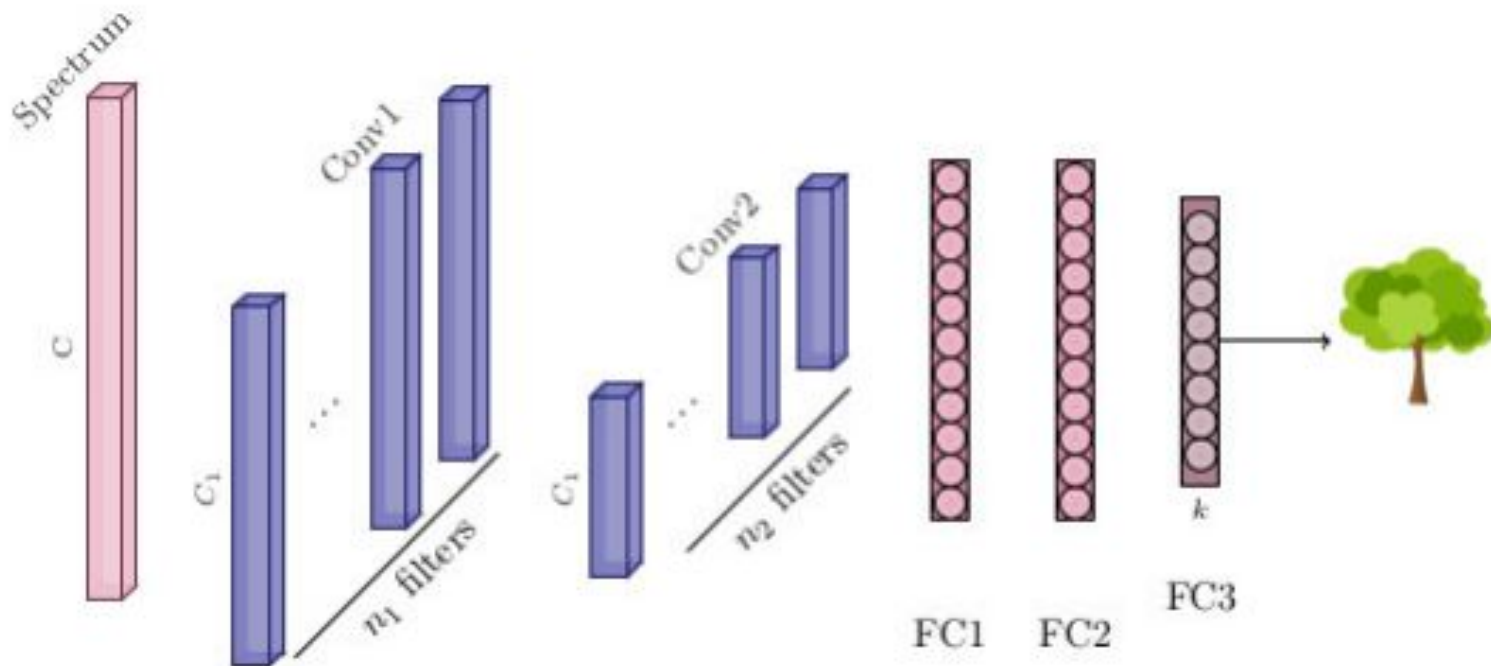IADF TC's Data Fusion Contest 2018

C 1 C 2 F1

3D convolution operation

Kernels $2@K_1^1 \times K_2^1 \times K_3^1$

3D convolution operation

Kernels $4@K_1^2 \times K_2^2 \times K_3^3$

Fully connected layer

classification

HSI $M \times N \times L$

$S \times S \times L$

Feature 1
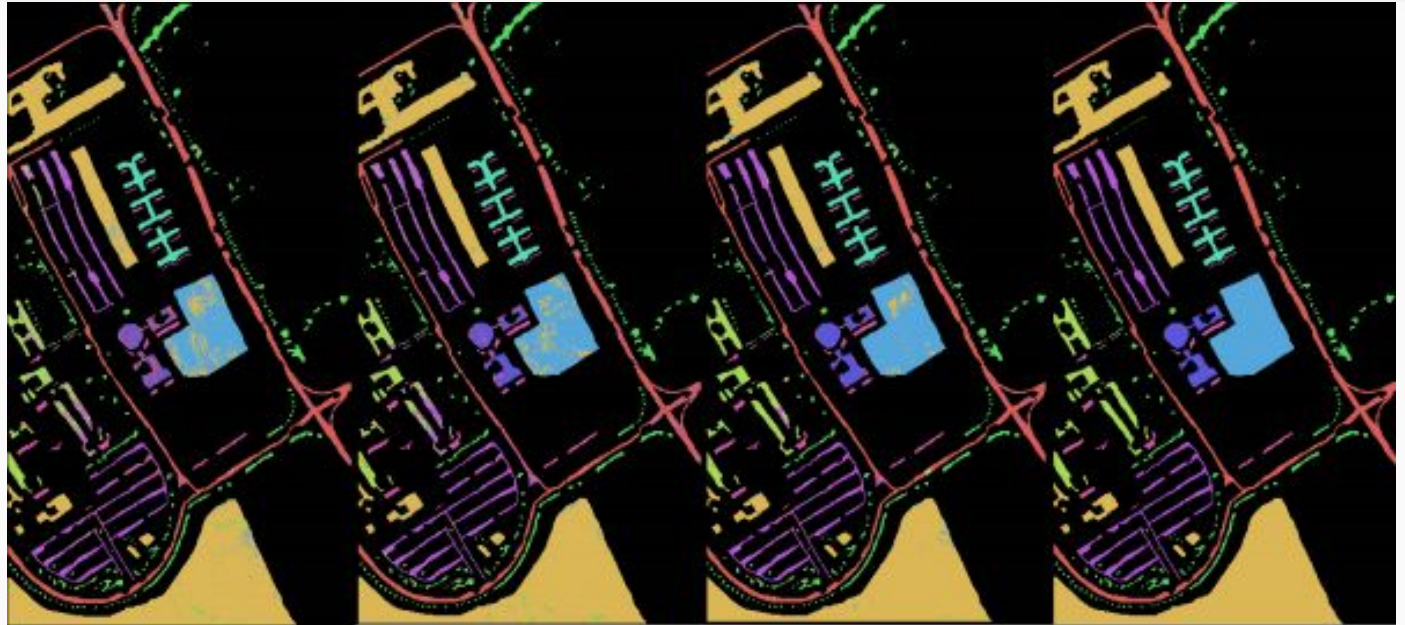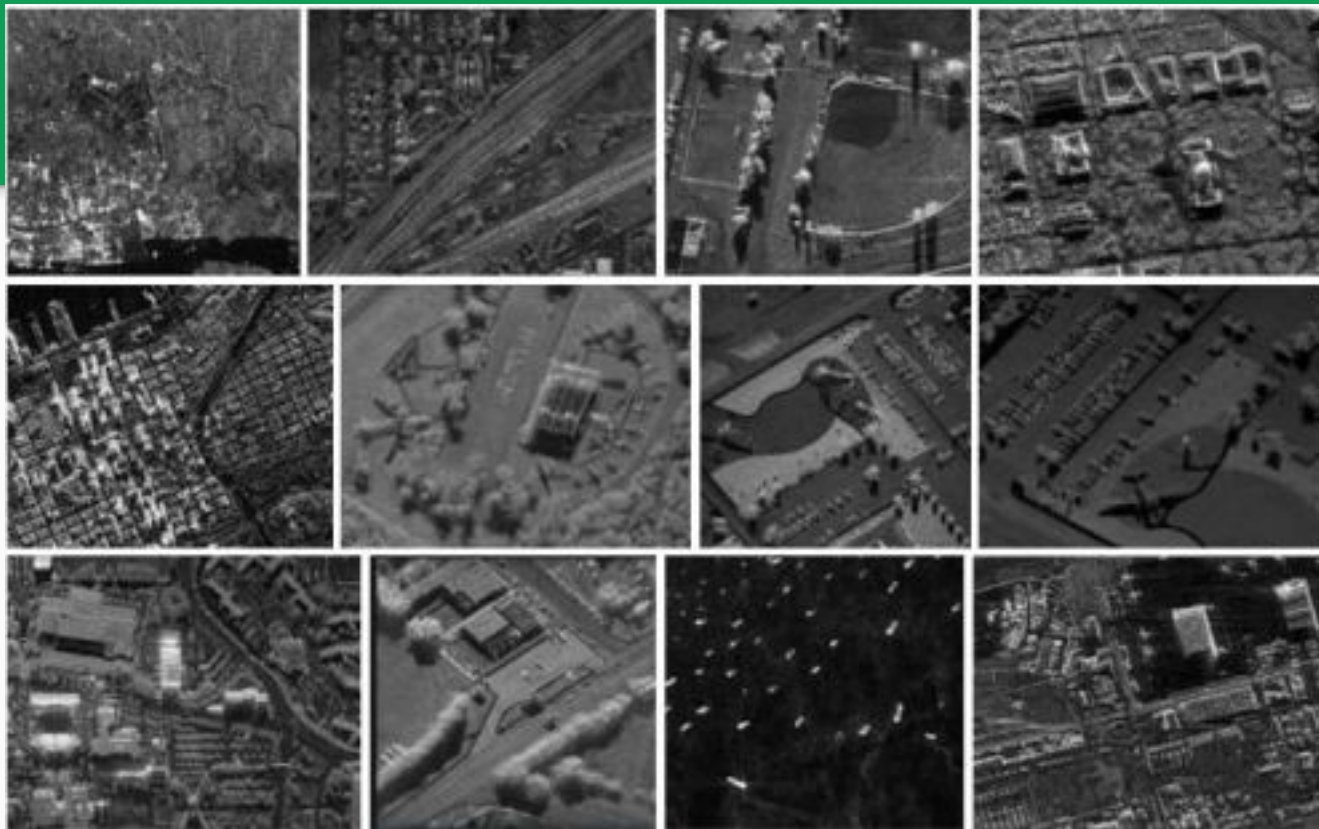
Feature 2

Feature 3

Category

Classification of Hyperspectral Data

Figure: CNN 1D

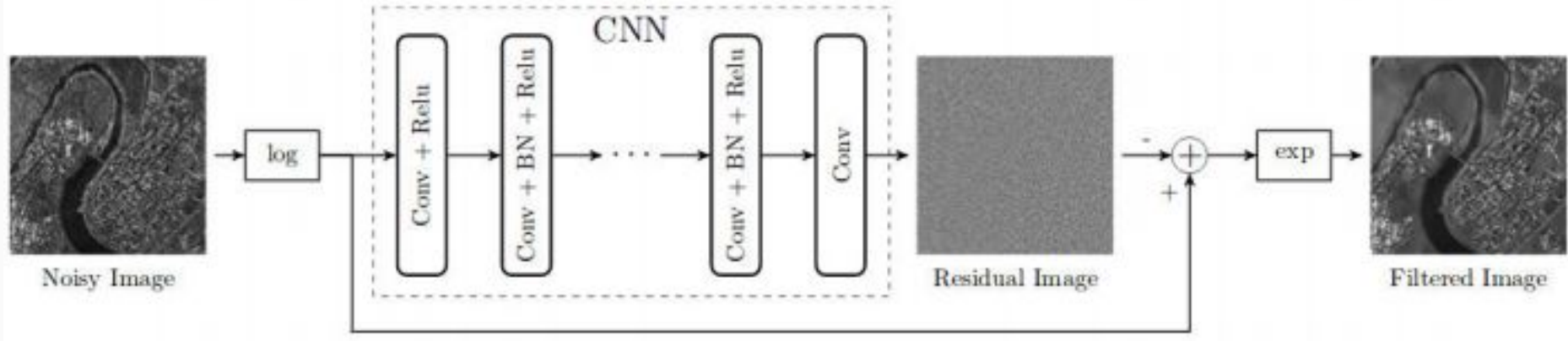# Classification of Hyperspectral Data

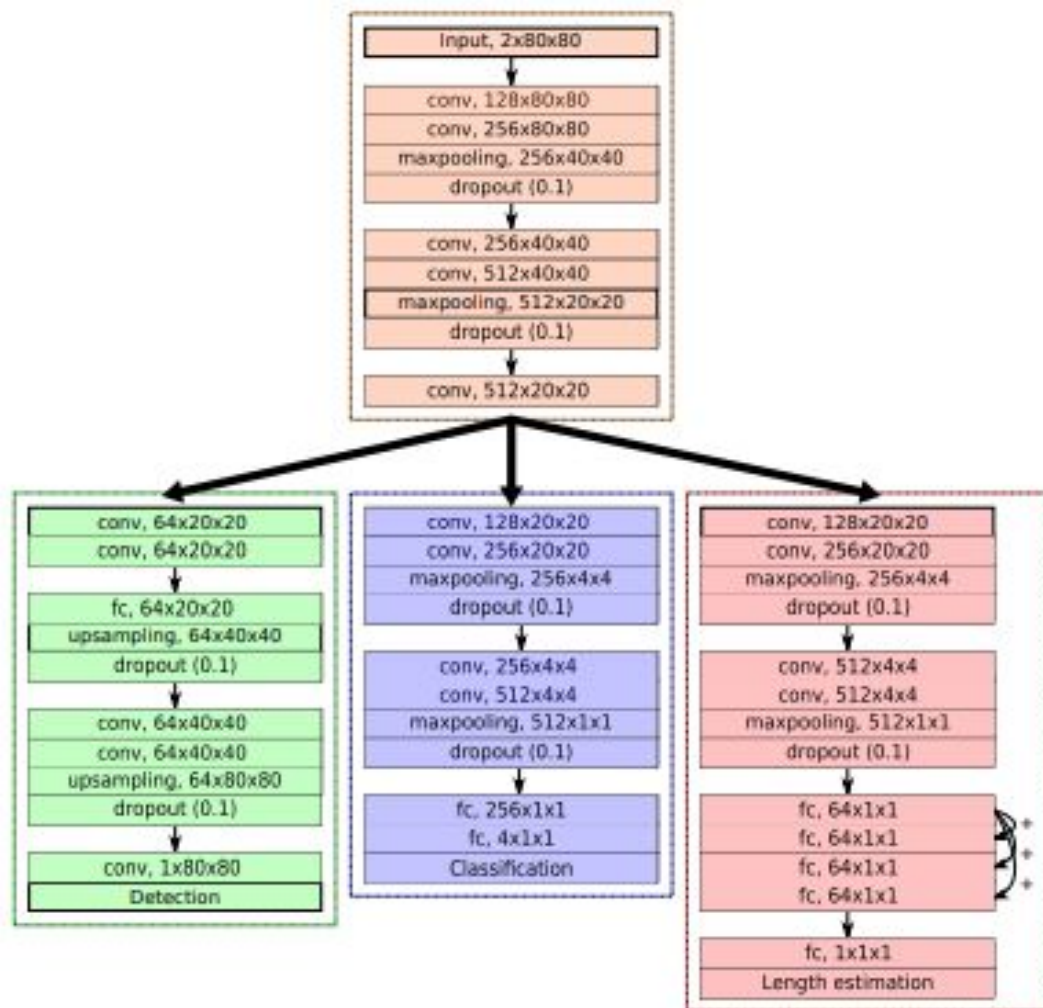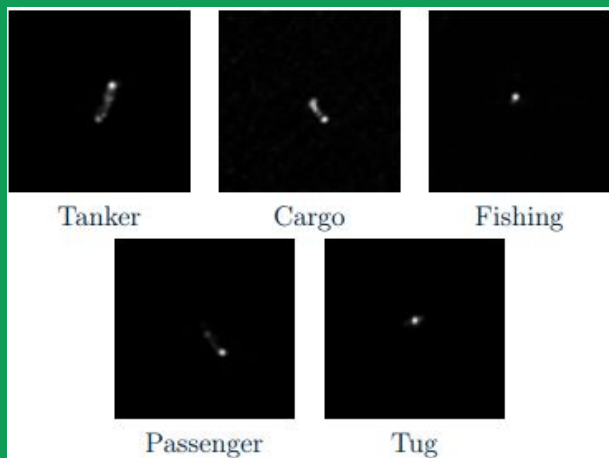blesaux.github.io/courses/JURSE_Deep
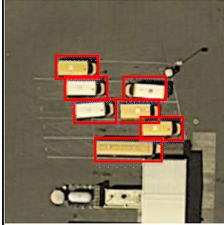Learning_for_Remote_Sensing_Tutorial.pdf

Deep Learning on SAR
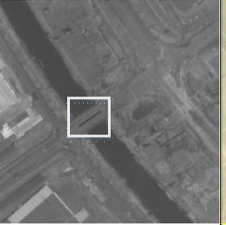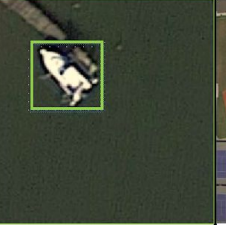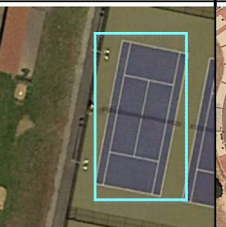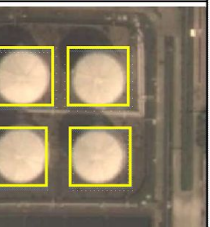
Despeckling of SAR Data

Object characterization for SAR Data

Tanker   Cargo   Fishing

Passenger   Tug

Input, 2x80x80

conv, 128x80x80
conv, 256x80x80
maxpooling, 256x40x40
dropout (0.1)

conv, 256x40x40
conv, 512x40x40
maxpooling, 512x20x20
dropout (0.1)

conv, 512x20x20

conv, 64x20x20
conv, 64x20x20

fc, 64x20x20
upsampling, 64x40x40
dropout (0.1)

conv, 64x40x40
conv, 64x40x40
upsampling, 64x80x80
dropout (0.1)

conv, 1x80x80
Detection

conv, 128x20x20
conv, 256x20x20
maxpooling, 256x4x4
dropout (0.1)

conv, 256x4x4
conv, 512x4x4
maxpooling, 512x1x1
dropout (0.1)

fc, 256x1x1
fc, 4x1x1
Classification

conv, 128x20x20
conv, 256x20x20
maxpooling, 256x4x4
dropout (0.1)

conv, 512x4x4
conv, 512x4x4
maxpooling, 512x1x1
dropout (0.1)

fc, 64x1x1
fc, 64x1x1
fc, 64x1x1
fc, 64x1x1

fc, 1x1x1
Length estimation

Remote Sensing and Object Detection

| Large vehicle | Swimming pool | Helicopter | Bridge | Plane | Ship | Soccer ball field | Basketball court |

| Ground track field | Small vehicle | Harbor | Baseball diamond | Tennis court | Roundabout | Storage tank |

Two-Step Object Detection
and
One-Step Object Detection
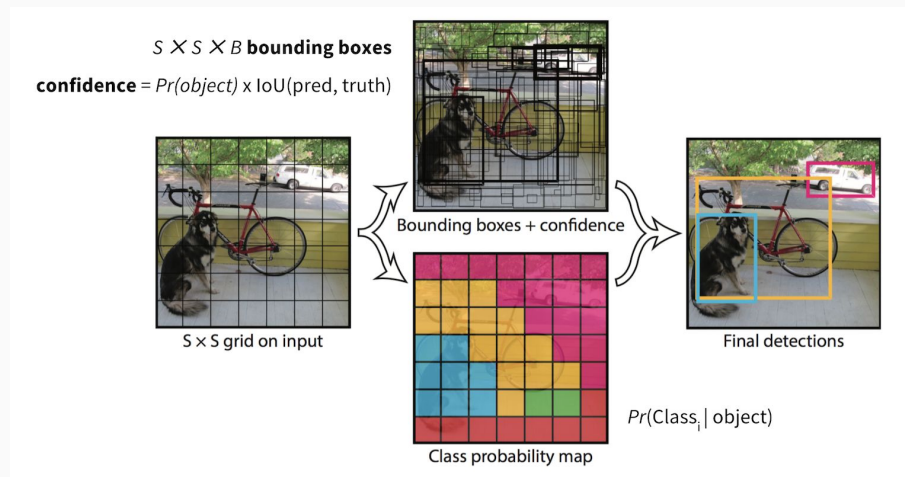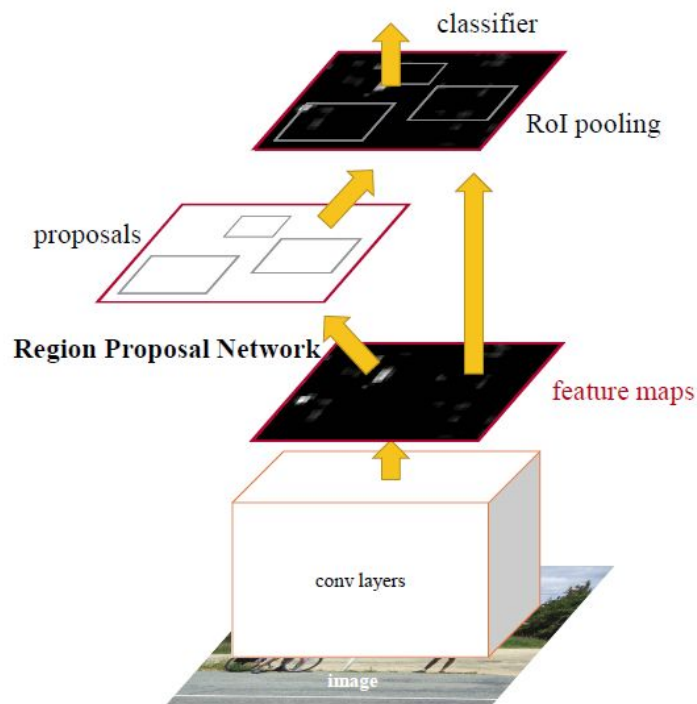
ML And DL Based Object Detection

ML Based Object Detection:
- Viola–Jones object detection framework based on Haar features
- Scale-invariant feature transform (SIFT)
- Histogram of oriented gradients (HOG) features

DL Based Object Detection
- R-CNN
- Fast R-CNN
- Faster R-CNN
- YOLO (You Only Look Once)
- SSD (Single Shot MultiBox Detector)
- Retina Net
- RefineDet (Single-Shot Refinement Neural Network for Object Detection)
- Deformable convolutional networks

Object Detection and OpenCV

Frameworks
- Caffe
- TensorFlow
- Torch DarkNet

Models
- AlexNet
- GoogLeNet
- ResNet
- SqueezeNet
- VGG
- ENet
- VGG-based SSD
- MobileNet-based SSD

Object Detection and OpenCV Algorithm

- Template Matching
- Cascade Classifier
- LBP – Local Binary Pattern
- HOG – Histogram of Oriented Gradients
- Convolutional Neural Network (CNN)

Tensorflow Object Detection API

Model name	Speed (ms)	COCO mAP[^1]	Outputs
ssd_mobilenet_v1_coco	30	21	Boxes
ssd_mobilenet_v1_0.75_depth_coco ☆	26	18	Boxes
ssd_mobilenet_v1_quantized_coco ☆	29	18	Boxes
ssd_mobilenet_v1_0.75_depth_quantized_coco ☆	29	16	Boxes
ssd_mobilenet_v1_ppn_coco ☆	26	20	Boxes
ssd_mobilenet_v1_fpn_coco ☆	56	32	Boxes
ssd_resnet_50_fpn_coco ☆	76	35	Boxes
ssd_mobilenet_v2_coco	31	22	Boxes
ssd_mobilenet_v2_quantized_coco	29	22	Boxes
ssdlite_mobilenet_v2_coco	27	22	Boxes
ssd_inception_v2_coco	42	24	Boxes
faster_rcnn_inception_v2_coco	58	28	Boxes
faster_rcnn_resnet50_coco	89	30	Boxes
faster_rcnn_resnet50_lowproposals_coco	64		Boxes
rfcn_resnet101_coco	92	30	Boxes
faster_rcnn_resnet101_coco	106	32	Boxes
faster_rcnn_resnet101_lowproposals_coco	82		Boxes

Faster R-CNN

YOLO

S × S grid on input

Bounding boxes + confidence

Class probability map

Final detections
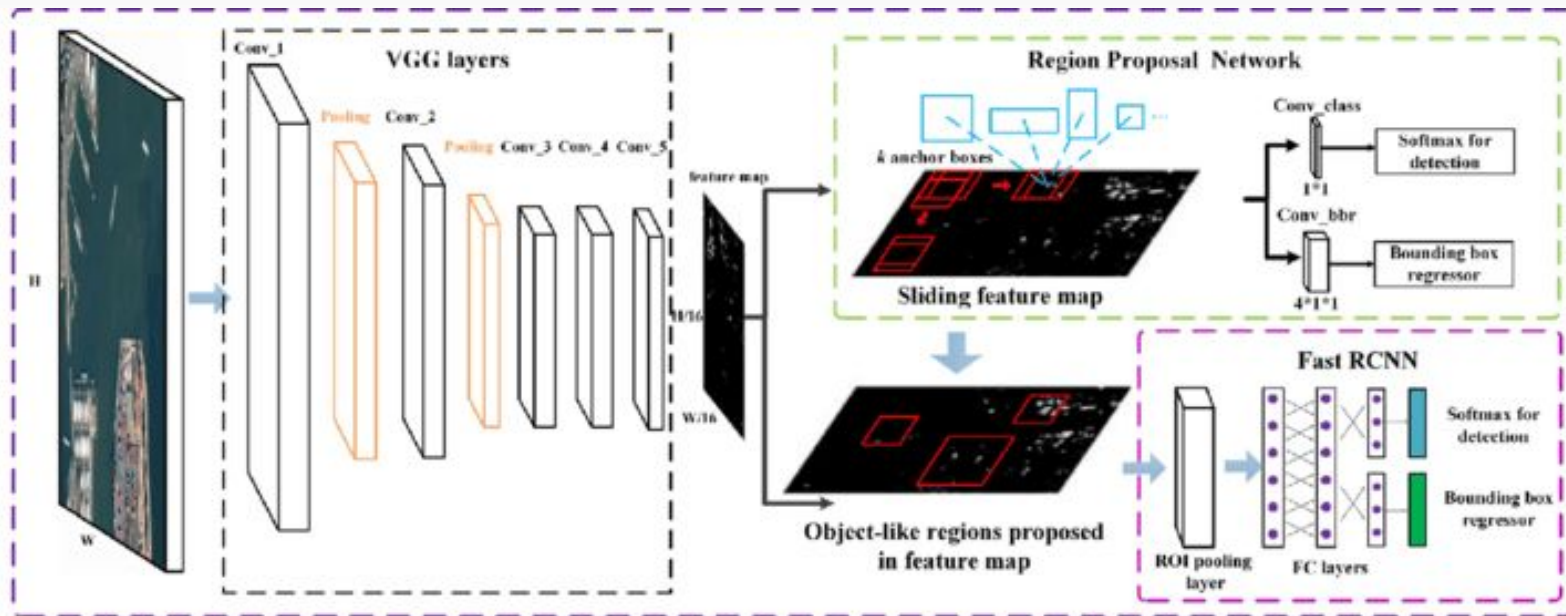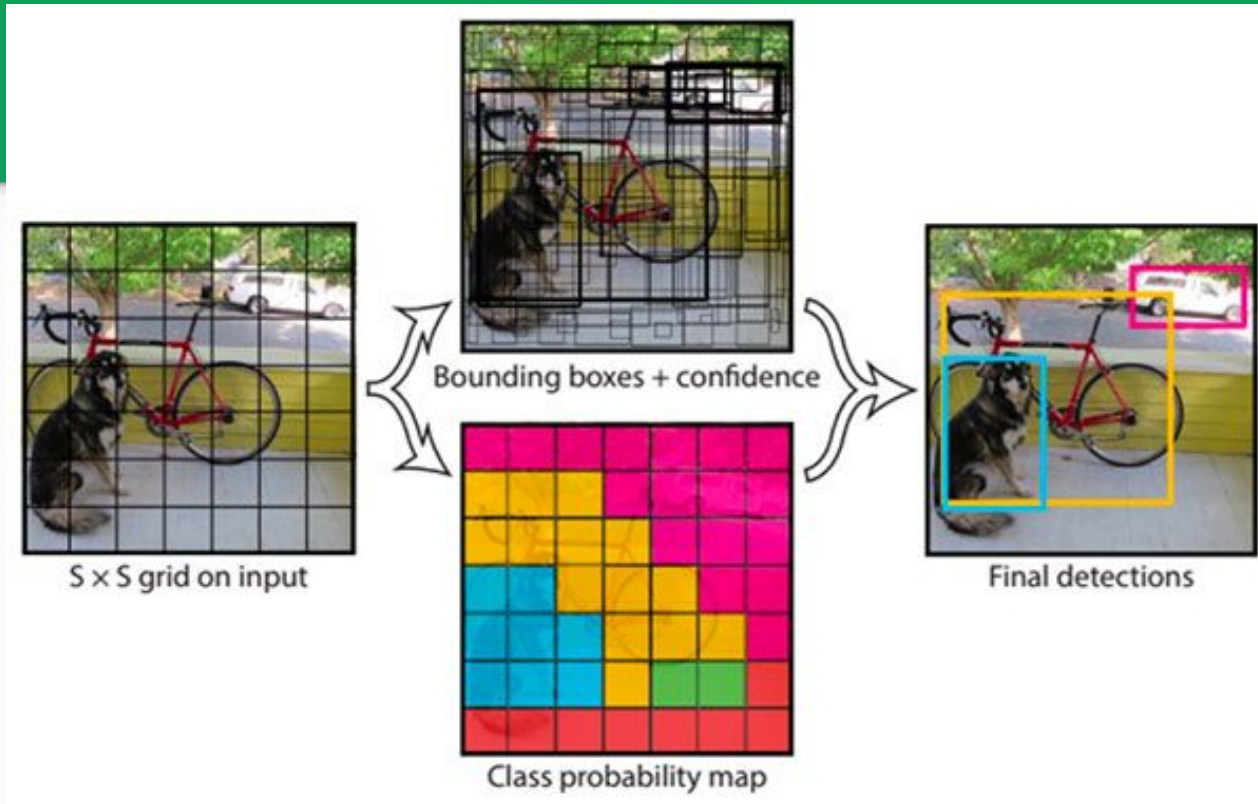
TF	miss detection rate	Recall	FP	false detection rate	TP	all
16	7.34%	92.66%	29	13.30%	206	218

Test süresi

R-CNN	Fast R-CNN	Faster R-CNN	YOLO
64.8	3.3	0.9	0.1

SSD - Single Shot Detector

RetinaNet

(a) Backbone network

(b) FPN

(c) Class subnet (top red) and box subnet (bottom in purple)

Class +box subnets

Class +box subnets

Class +box subnets
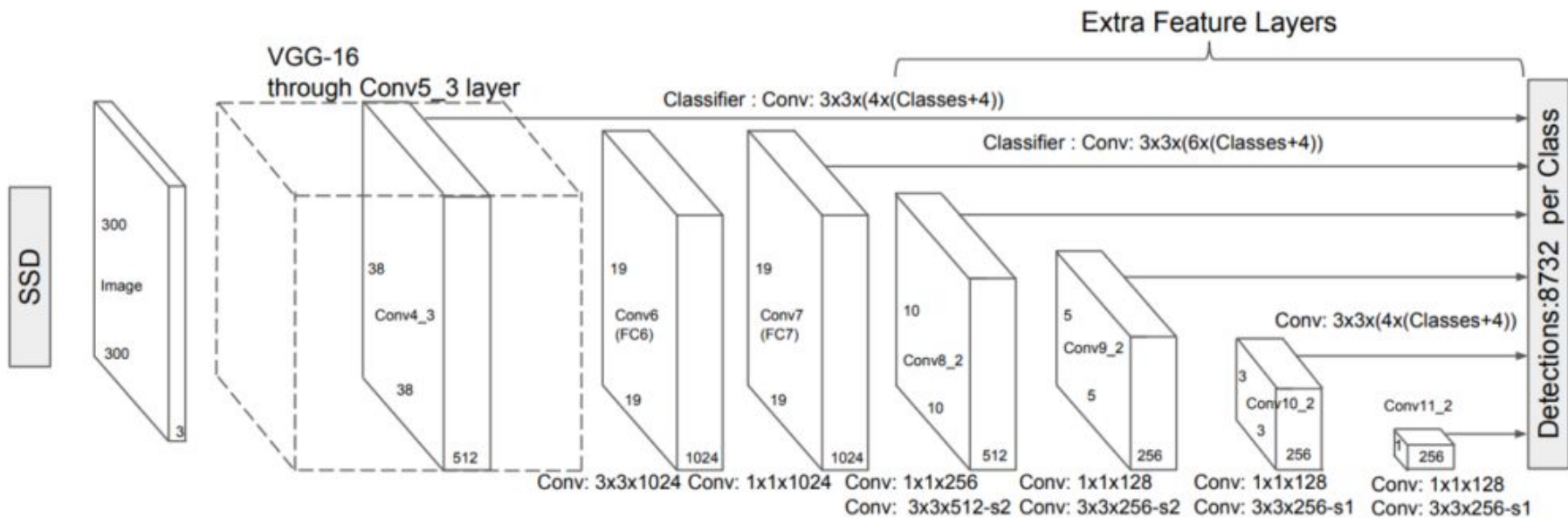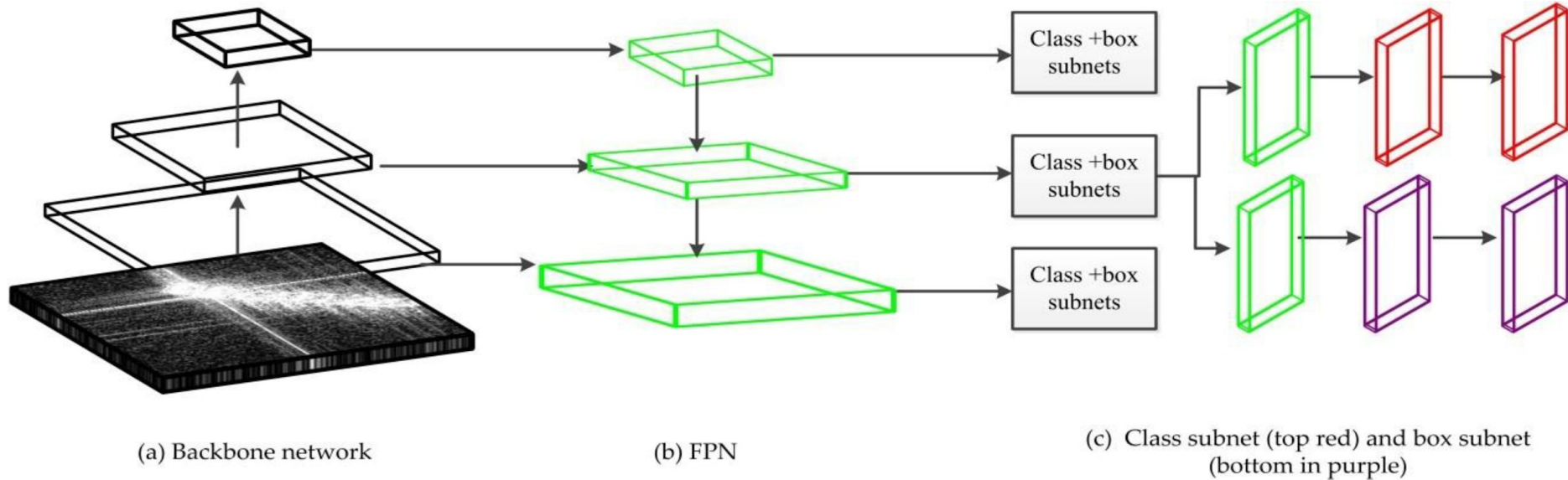
Object Detection Dataset

- COCO (Common Objects in Context)
- Kitti
- Open_images_v4
- Pascal VOC()
- Wider_Face

COCO
(Common Objects in Context)

Pascal VOC()

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{
    "info": info,
    "licenses": [license],
    "categories": [category],
    "images": [image],
    "annotations": [annotation]
}
```

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<annotation>
        <folder>Kangaroo</folder>
        <filename>00001.jpg</filename>
        <path>./Kangaroo/stock-12.jpg</path>
        <source>
                <database>Kangaroo</database>
        </source>
        <size>
                <width>450</width>
                <height>319</height>
                <depth>3</depth>
        </size>
        <segmented>0</segmented>
        <object>
                <name>kangaroo</name>
                <pose>Unspecified</pose>
                <truncated>0</truncated>
                <difficult>0</difficult>
                <bndbox>
                        <xmin>233</xmin>
                        <ymin>89</ymin>
                        <xmax>386</xmax>
                        <ymax>262</ymax>
                </bndbox>
        </object>
</annotation>
```

Proposed - Public General Datasets

- ISPRS datasets: semantic labeling, reconstruction

  https://www.isprs.org/data/

- Toronto Massachusetts Roads and Buildings Dataset

  https://www.cs.toronto.edu/~vmnih/data/

- IEEE GRSS Data Fusion Contests:

  http://www.grss-ieee.org/community/technical-committees/data-fusion/data-fusion-contest/

- IEEE GRSS: hyperspectral datasets with standard train/test splits (DFC2018, Pavia, Indian Pines)

  http://dase.grss-ieee.org/

- INRIA Aerial Semantic labeling dataset: buildings

  https://project.inria.fr/aerialimagelabeling/

- XView: objects in aerial images

  http://xviewdataset.org/

- DOTA: Detecting Objects in Aerial images

  https://captain-whu.github.io/DOTA/dataset.html

Practical Session and Sources

https://colab.research.google.com/drive/1Om2H3T9Kt4CtBBMieN0JHdR5-ZqJ1Cbe
https://drive.google.com/drive/folders/10AgLjM52sbEsMSO44tC7yvh93IFKcfv_

https://github.com/qubvel/segmentation_models

https://github.com/AlexeyAB/darknet

Please visit on YouTube video to talk about this presentation and practice session.
You can find the video link in the my GitHub repo.

THANKS

Does anyone have any questions?

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