AUTOMATIC VEHICLE DETECTION AND CLASSIFICATION SYSTEM USING ADVANCED DEEP LEARNING ARCHITECTURES

Narong Boonsirisumpun

Introduction

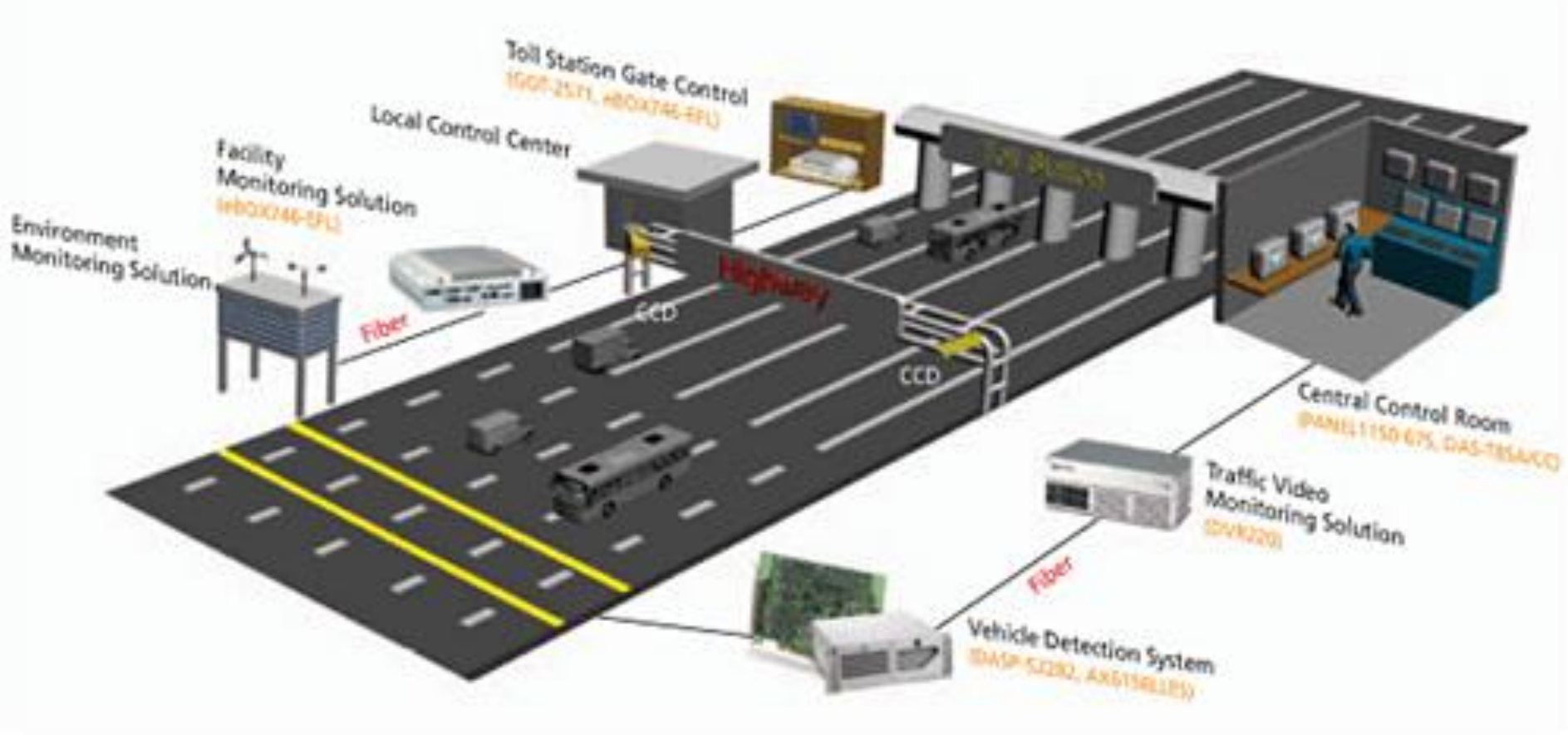
- Image recognition is one of the most important steps in the image processing method. The goal is to extract the important features from the digital image and transform them to another usable form. One of the challenging problems is an automatic vehicle detection and classification system. Its goal is to segment and extract the object area from the video image data and describe that this object is a vehicle or not? what type of this vehicle is? and what is the other additional information about this vehicle?
- In this proposal, we propose to study and apply several models of Deep Learning (both for image recognition and image detection) into the automatic vehicle detection and classification problem. And the final goal is to develop a new deep learning model that can surpass other deep learning models we also use for this research. Which the experiment will be separated in three main issues: Vehicle Type Recognition, Vehicle Make Recognition, and License Plate Recognition.

Objectives

- To study the performance of Deep Learning Algorithms in Image Detection and Classification problem.
- To take the experiment and analyze the performance of several Deep Learning Algorithms in the Vehicle Type, Vehicle Make and License plate classification problem.
- To take the experiment and analyze the performance of several Deep Learning Algorithms in the Vehicle Type, Vehicle Make and License plate detection problem.

Overview and Related Work

Vehicle Detection System



Vehicle Type

a) Sedan

b) Hatchback

c) SUV

d) Pick-up

e) Van

Vehicle Make

TOP 12 CAR SALES VOLUME

By market share in 2017 (11 months)

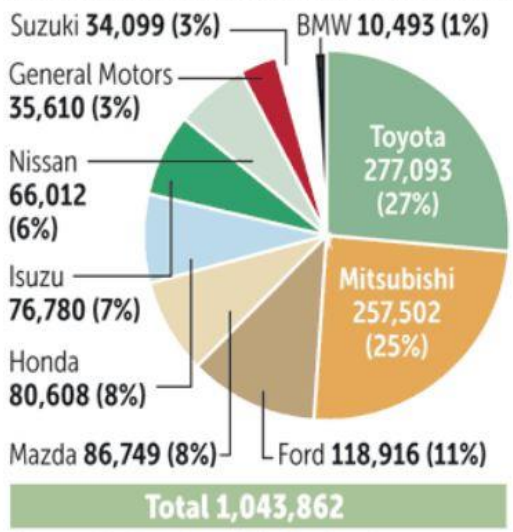
Brand	Sales volume	YoY	Share
• Toyota	208,755	-3.8%	27.2%
• Isuzu	145,108	13.7%	18.9%
• Honda	113,305	16.8%	14.8%
• Mitsubishi	60,824	24.7%	7.9%
• Nissan	52,700	40.3%	6.9%
• Ford	49,428	37.5%	6.4%
• Mazda	45,098	18.5%	5.9%
• Suzuki	21,898	10.1%	2.9%
• Chevrolet	15,983	26.1%	2.1%
• Mercedes-Benz	12,563	20.3%	1.6%
• Hino	10,782	-2.9%	1.4%
• MG	10,085	39.1%	1.3%

Source: Toyota Motor Thailand

TOP CAR EXPORTERS

By maker in 2017 (11 months)

CBU volume and share



Total 1,043,862

Source: Federation of Thai Industries

BANGKOK POST GRAPHICS

Vehicle License Plate

4 wheel private car, no more than 7 seats (the most common license plate).

Private 2-door pickup truck.

Private van or vehicle with more than 7 seats.

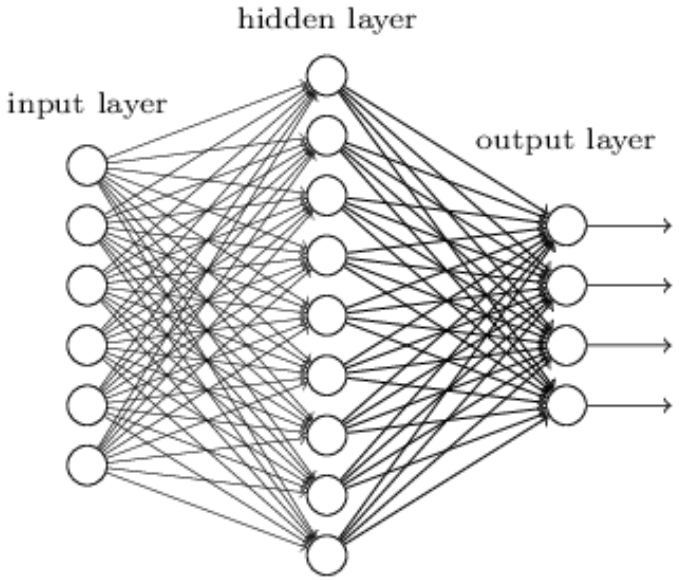
Temporary red plate issued by car dealer when buying a new car.

Taxis, buses and other chartered vehicles.

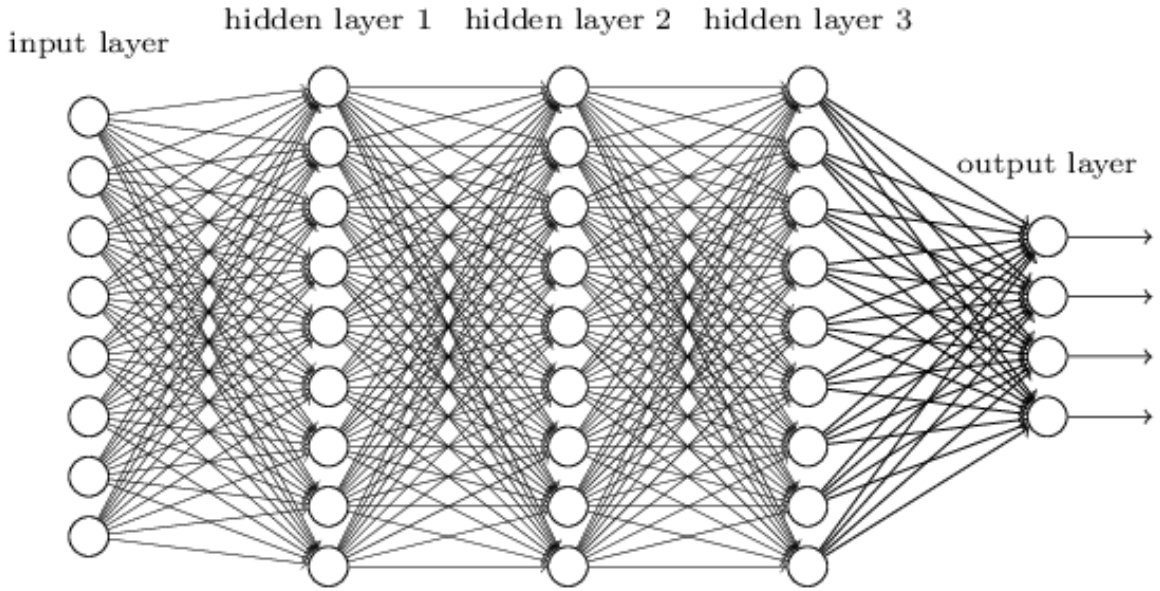
Vehicle License Plate

Deep Learning

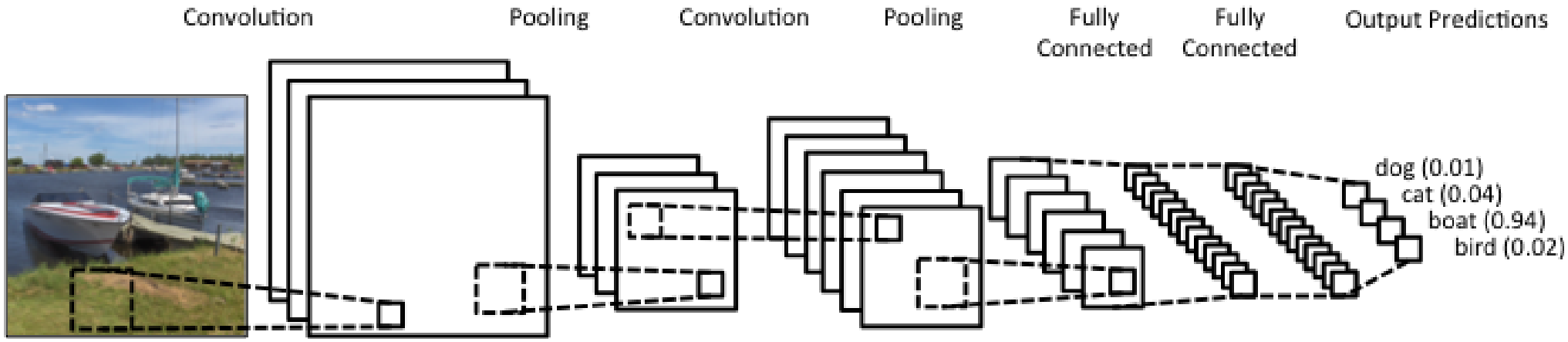
"Non-deep" feedforward neural network



Deep neural network

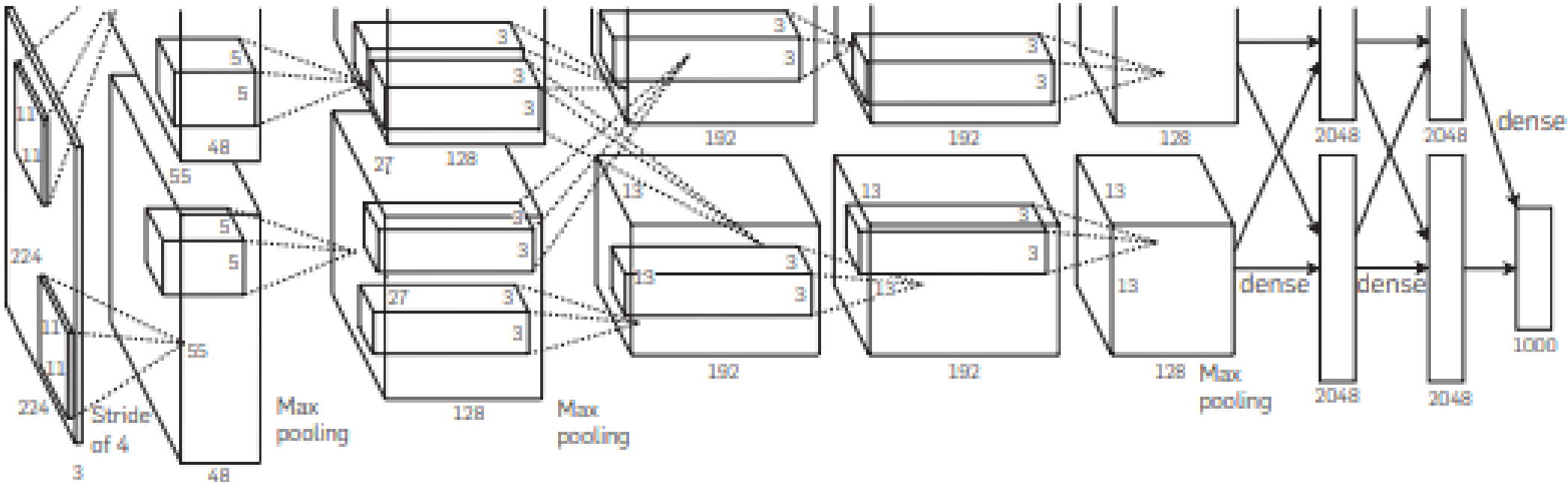


CONVOLUTIONAL NEURAL NETWORKS (CNNs)



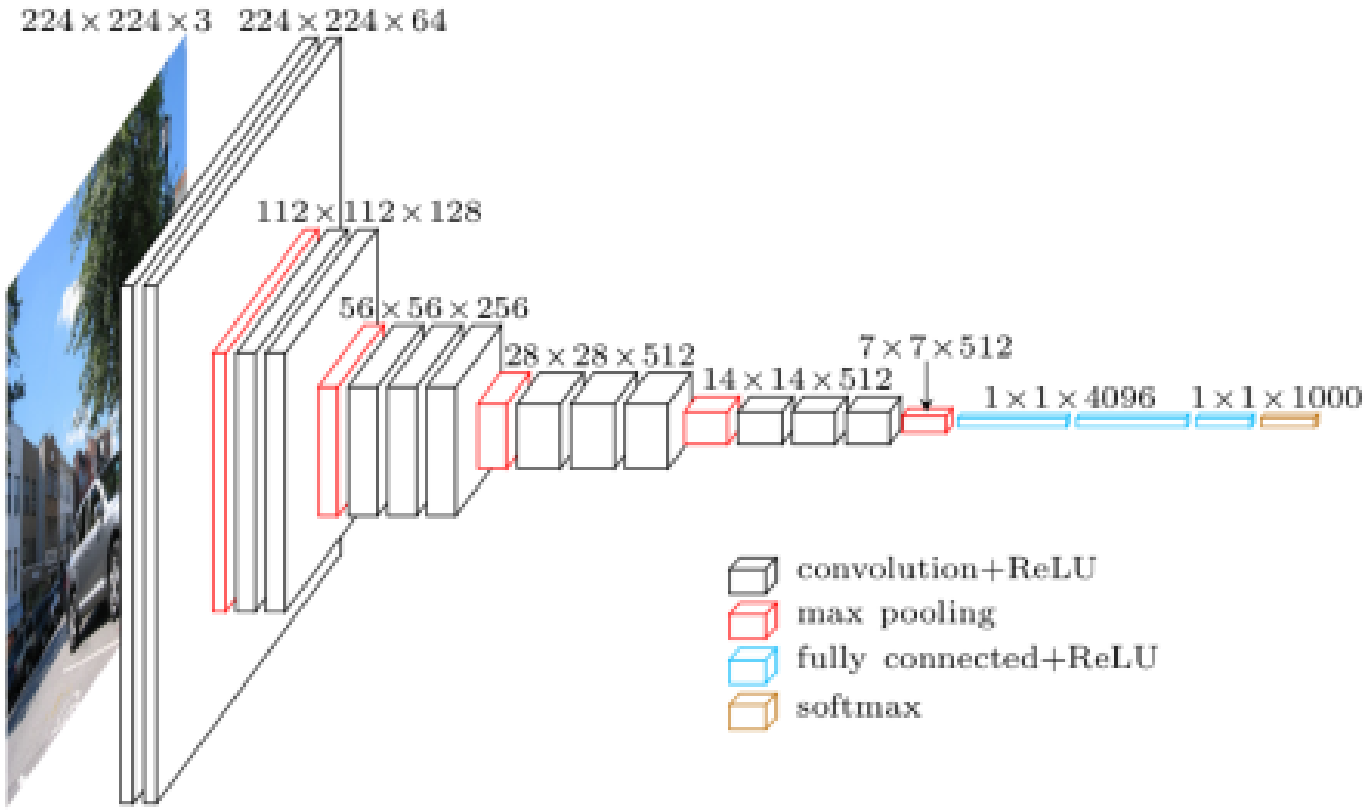
Deep Learning for Image Recognition

Alexnet



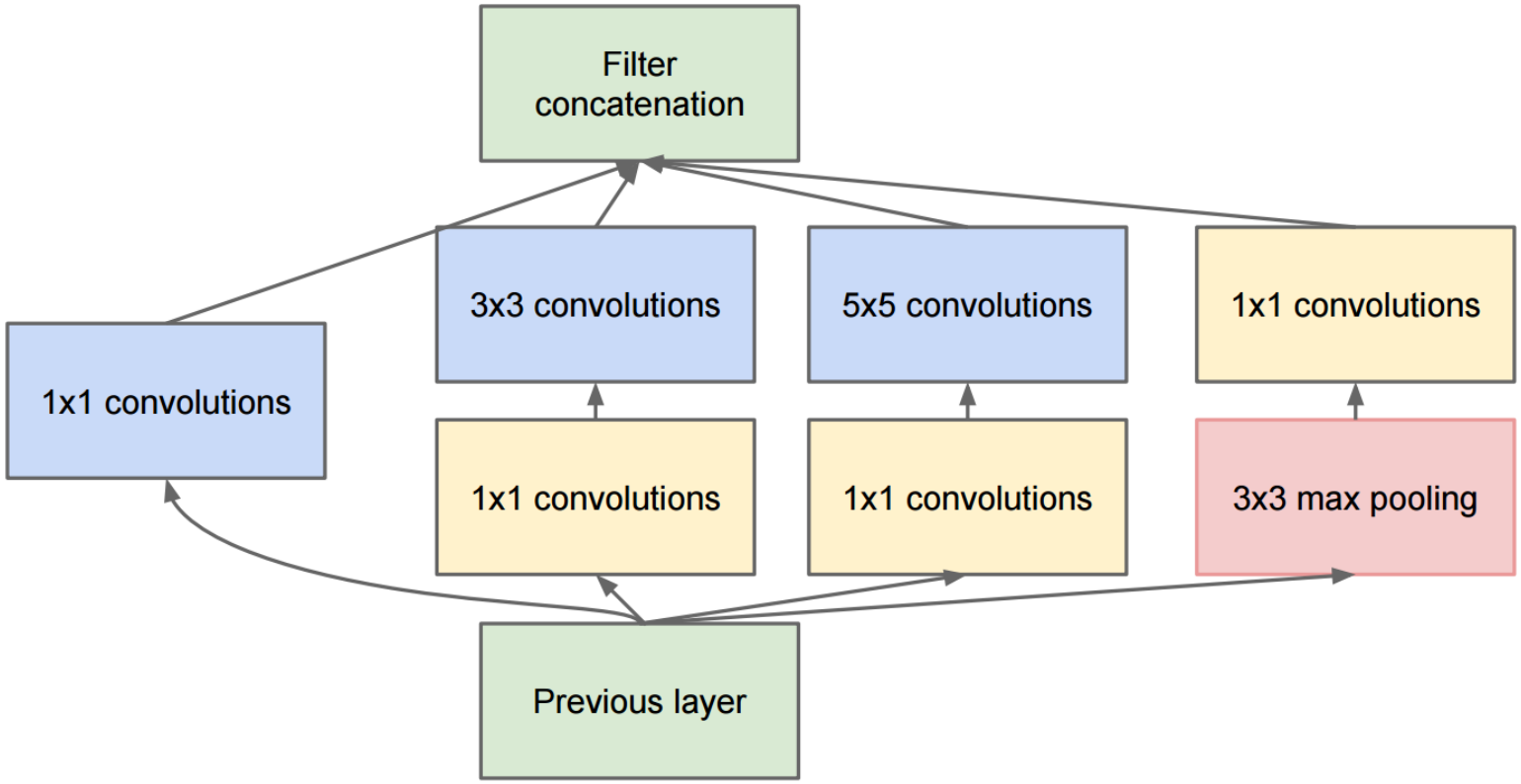
Source: Alex Krizhevsky, Geoffrey Hinton, and Ilya Sutskever (2010)

VGGNet



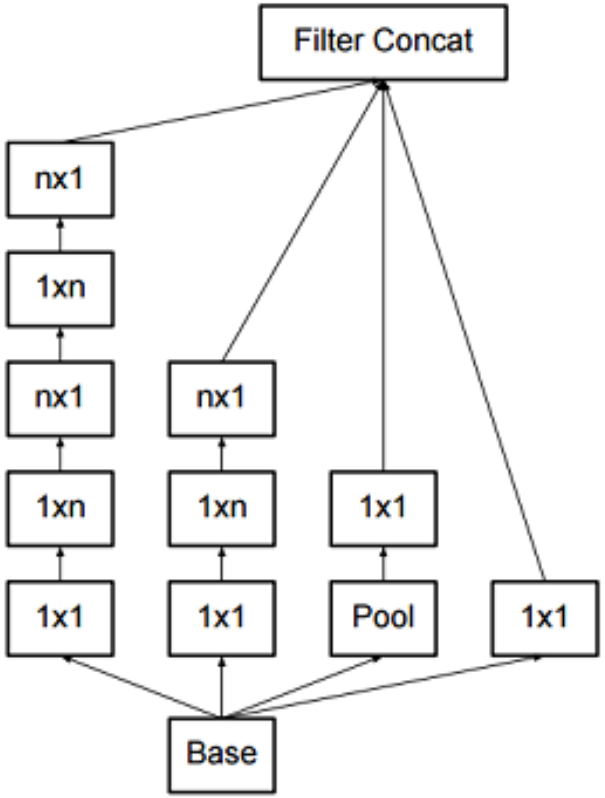
Source: Karen Simonyan and Andrew Zisserman (2014)

GoogLeNet (inception_v1)



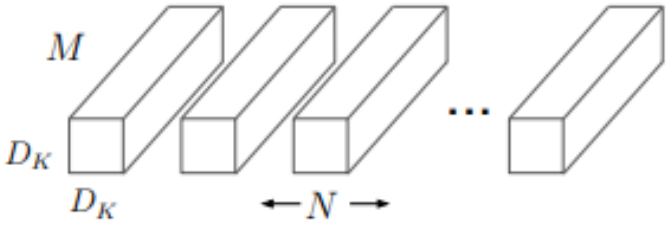
Source: Christian Szegedy et al. (2014)

GoogLeNet (inception_v2,3,4)

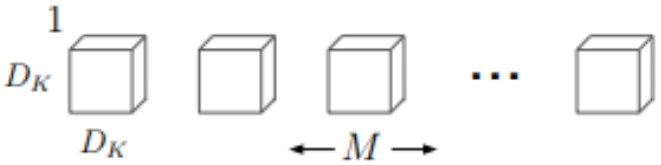


Source: Christian Szegedy et al. (2016)

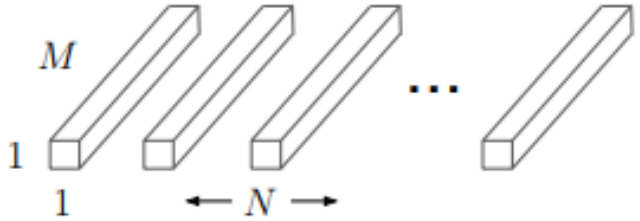
MobileNets



(a) Standard Convolution Filters



(b) Depthwise Convolutional Filters

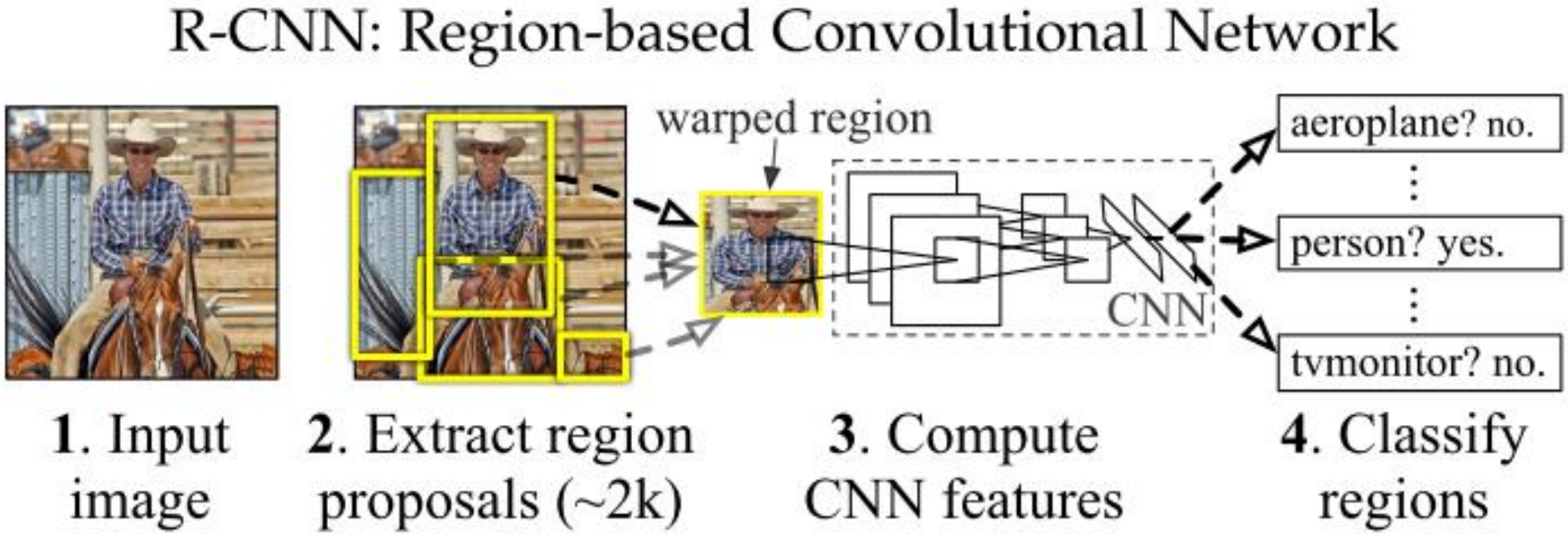


(c) 1×1 Convolutional Filters called Pointwise Convolution in the context of Depthwise Separable Convolution

Source: Andrew G. Howard et al. (2017)

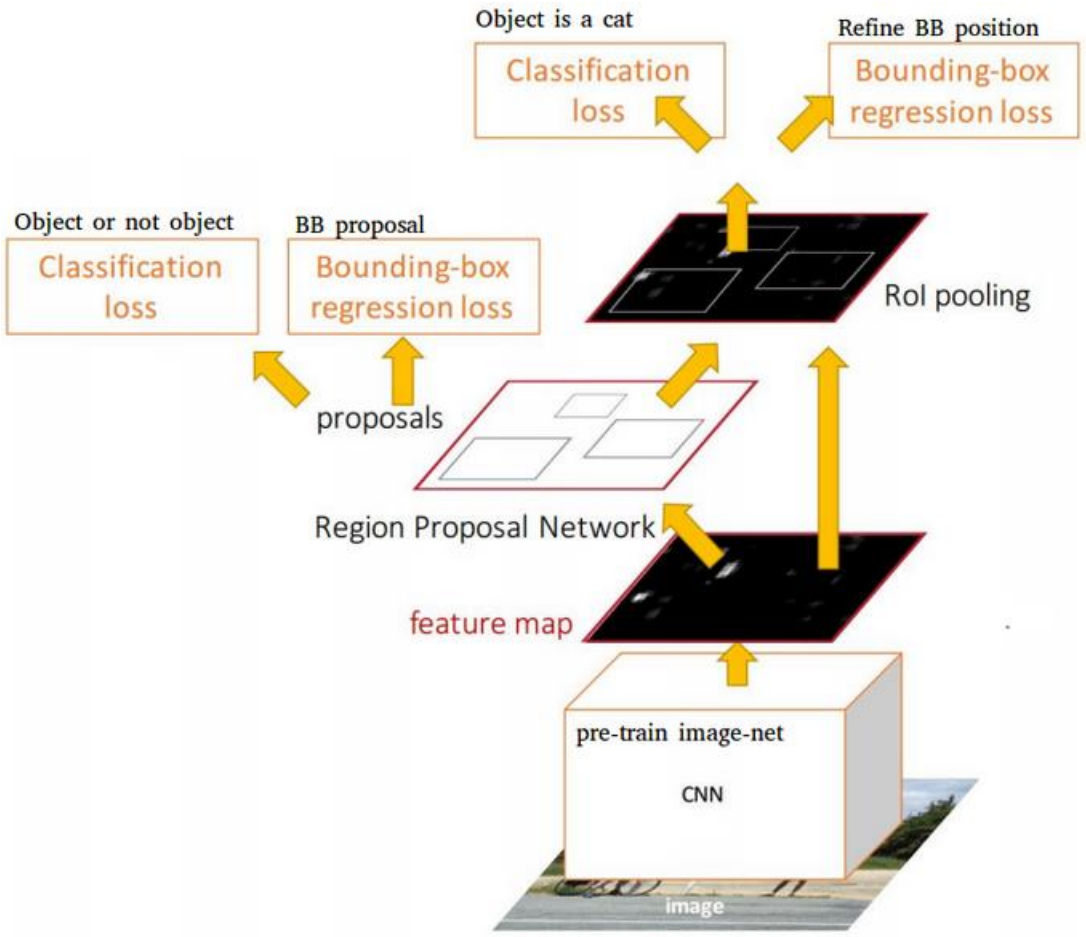
Deep Learning for Image Detection

R-cnn



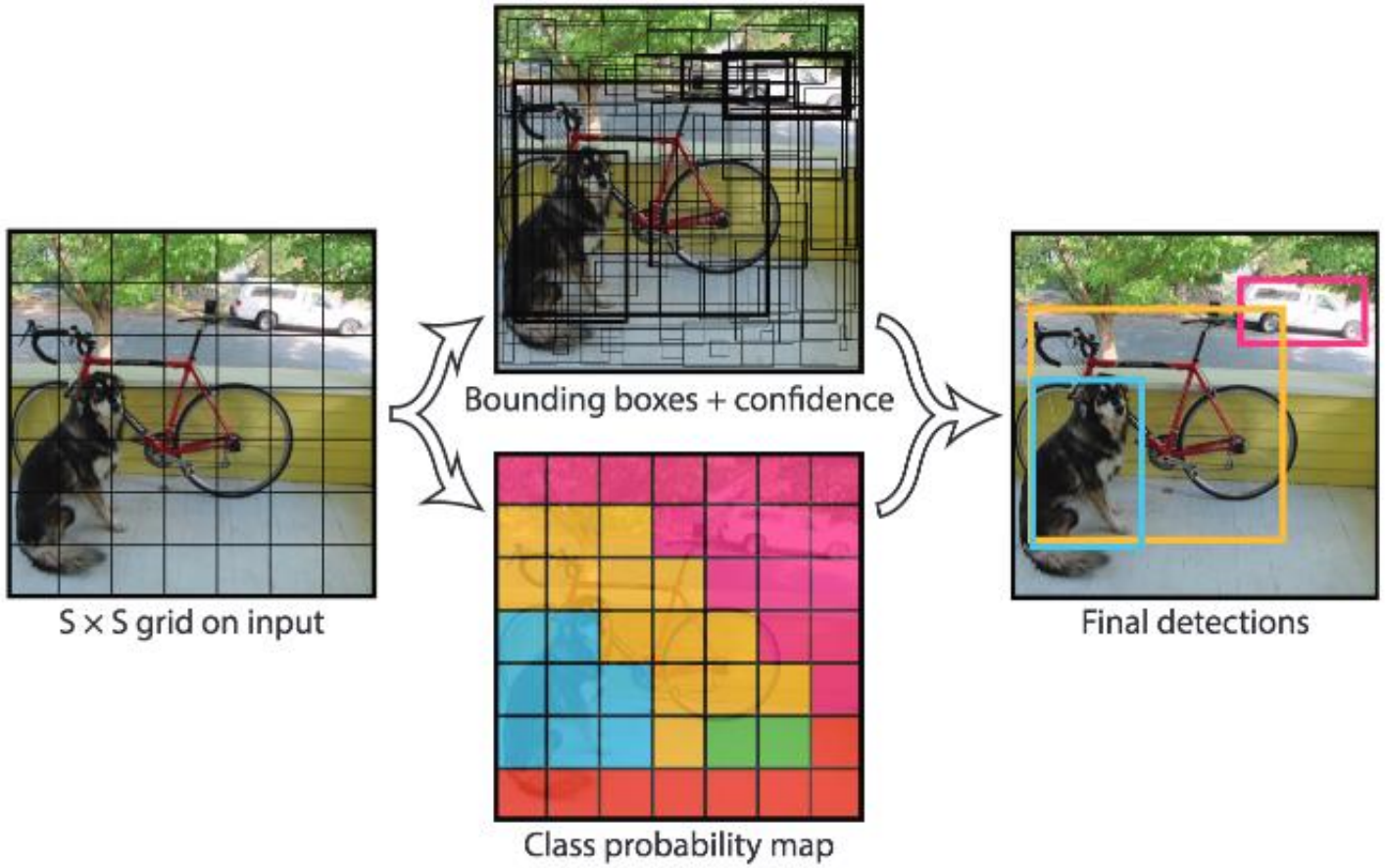
Source: Ross Girshick et al. (2014)

FASTER R-cnn



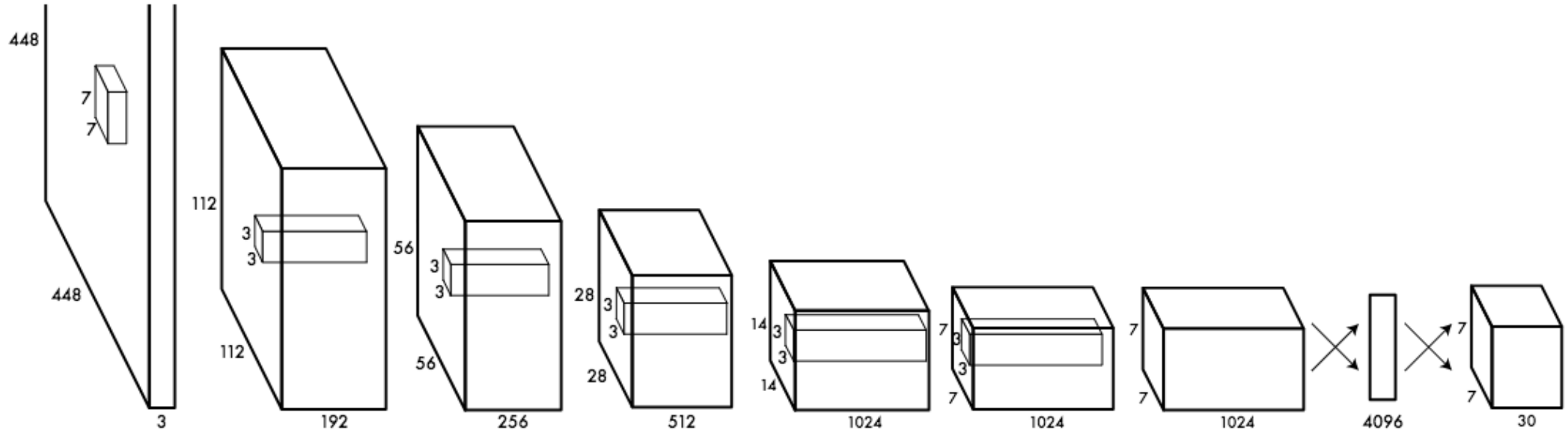
Source: Shaoqing Ren et al. (2015)

YOLO (You only look once)



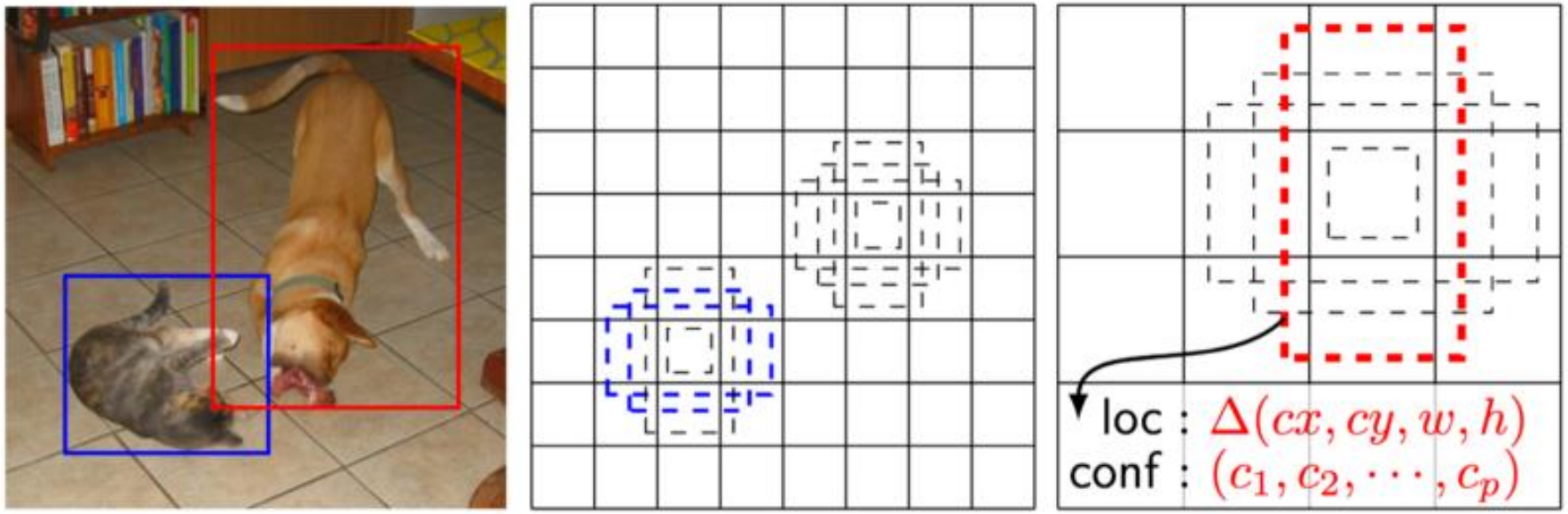
Source: Joseph Redmon et al. (2016)

YOLO (You only look once)



Source: Joseph Redmon et al. (2016)

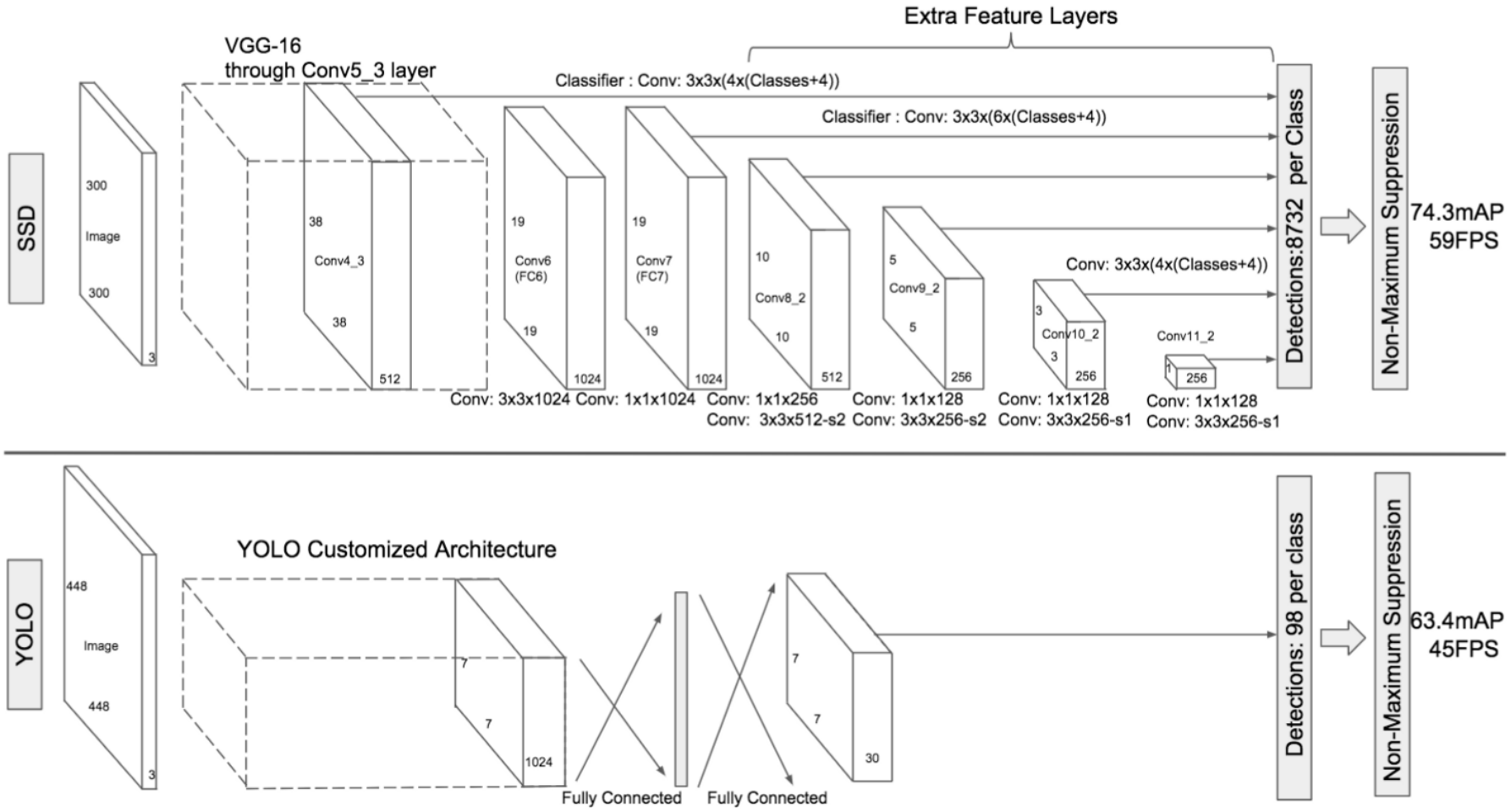
SSD (single shot multi-box detector)



(a) Image with GT boxes (b) 8×8 feature map (c) 4×4 feature map

Source: Wei Liu et al. (2016)

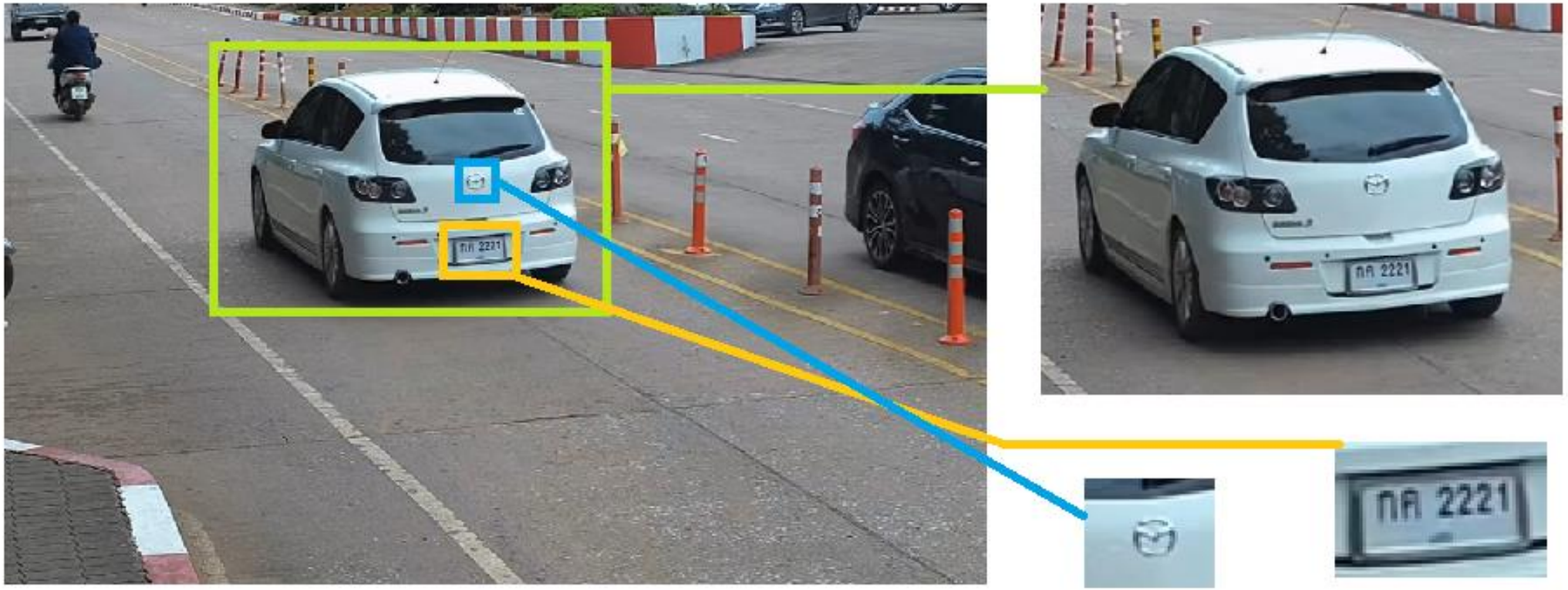
SSD (single shot multi-box detector)



Source: Wei Liu et al. (2016)

Experiments

Image Data collection



Examples of data

Experimental setup

Image Classification (Recognition)

- VGGNet
- GoogLeNet
- MobilesNet

Image Detection (Segmentation)

- R-CNN
- Faster R-CNN
- YOLO
- SSD

Focus Problem

- Vehicle Type
- Vehicle Make (Brand)
- License Plate

EVALUATION

1. The performance of Vehicle Type Recognition: Can deep learning detect and specify the type of vehicle (Sedan, Hatchback, SUV, Pick-up, and Van) in the image?
2. Vehicle Make Recognition: Can deep learning recognize the vehicle brand by only looking from an image?
3. License Plate Recognition: Can deep learning do a character recognition better than the state-of-the-art model such as OCR?
4. Which model is the best model for the vehicle detection and classification problem?
5. Can we develop a new model that can surpass all standard nowadays Deep Learning models?

References

- Simonyan, K. and Zisserman, A. (2014). Very deep convolutional networks for large-scale image recognition. arXiv:1409.1556.
- Howard, A.G., Menglong Z., Bo C., Dmitry K., Weijun W., Tobias W., Marco A., and Hartwig A. (2017). Mobilenets: Efficient convolutional neural networks for mobile vision applications. arXiv:1704.04861.
- Szegedy, C., Liu, W., Jia, Y., Sermanet, P., Reed, S., Anguelov, D., Erhan, D., Vanhoucke, V. and Rabinovich, A. (2015). Going deeper with convolutions. arXiv:1409.4842, 7.
- Szegedy, C., Vanhoucke, V., Ioffe, S., Shlens, J. and Wojna, Z. (2016). Rethinking the inception architecture for computer vision. IEEE on Computer Vision and Pattern Recognition, pp. 2818-2826.
- Girshick, R., Donahue, J., Darrell, T., and Malik, J. (2014). Region-based convolutional networks for accurate object detection and segmentation. IEEE transactions on pattern analysis and machine intelligence 38, no. 1, pp. 142-158.
- Ren, S., He, K., Girshick, R. and Sun, J. (2015). Faster r-cnn: Towards real-time object detection with region proposal networks. Advances in neural information processing systems ,pp. 91-99.
- Redmon, J., Divvala, S., Girshick, R. and Farhadi, A. (2016). You only look once: Unified, real-time object detection. Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 779-788.
- Liu, Wei, Dragomir Anguelov, Dumitru Erhan, Christian Szegedy, Scott Reed, Cheng-Yang Fu, and Alexander C. Berg. (2016). Ssd: Single shot multibox detector. European conference on computer vision, pp. 21-37. Springer, Cham.