YOLO
MobileNet

Vladislav Goncharenko
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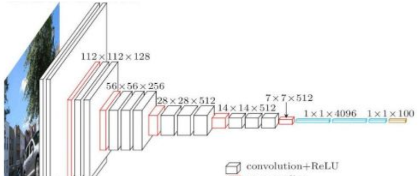
Outline

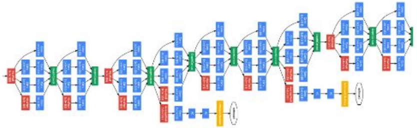
- Recap
- Focal Loss
- Non-Maximum Suppression
- YOLO
    - v1
    - v2
    - V3
- Separable convolutions
- MobileNet

Recap

- Computer Vision tasks
  - Classification
  - Localisation
  - Detection
  - Semantic Segmentation
  - Instance Segmentation
- Metrics
  - IoU
  - mAP
- Datasets
  - PASCAL VOC
  - ImageNet
  - COCO
  - Open Images
- R-CNN
- Fast R-CNN
- Faster R-CNN

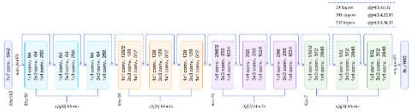


Девушка, которая мне нравится

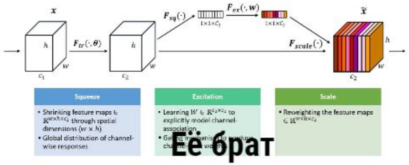


Её отец

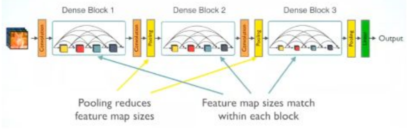
Squeeze-and-Excitation Module



Её мать

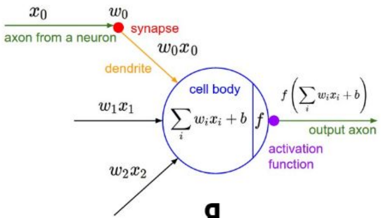


Её брат



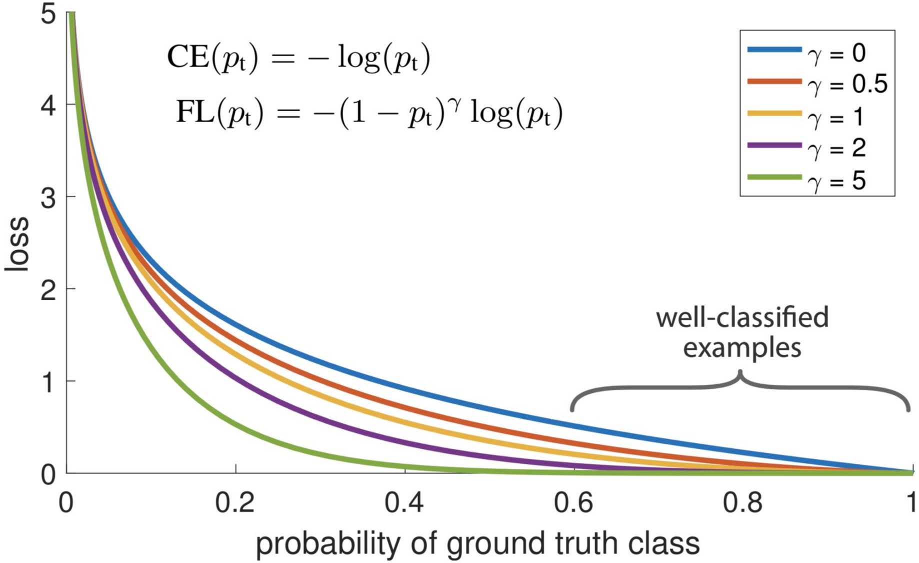
Dense Block 1
Dense Block 2
Dense Block 3
Output
Pooling reduces feature map sizes
Feature map sizes match within each block

Её бывший



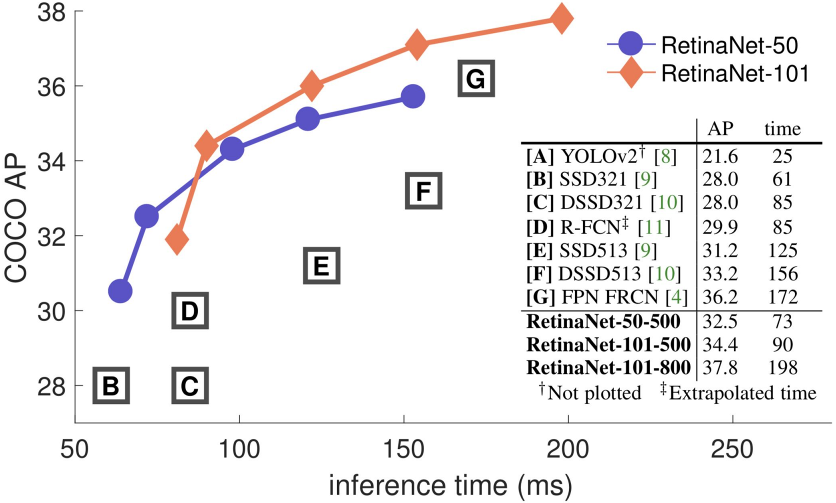
Я

Focal Loss



$$\mathrm{CE}(p_t) = -\log(p_t)$$

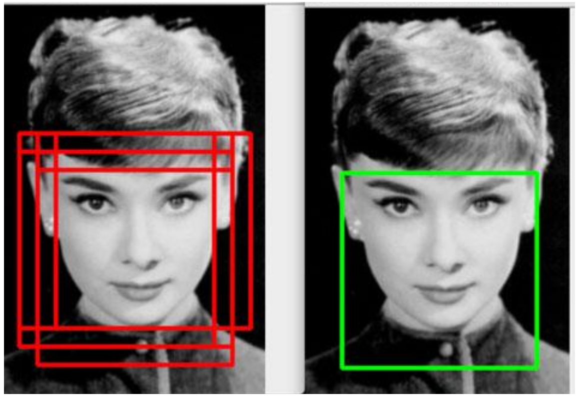
$$\mathrm{FL}(p_t) = -(1-p_t)^{\gamma}\log(p_t)$$

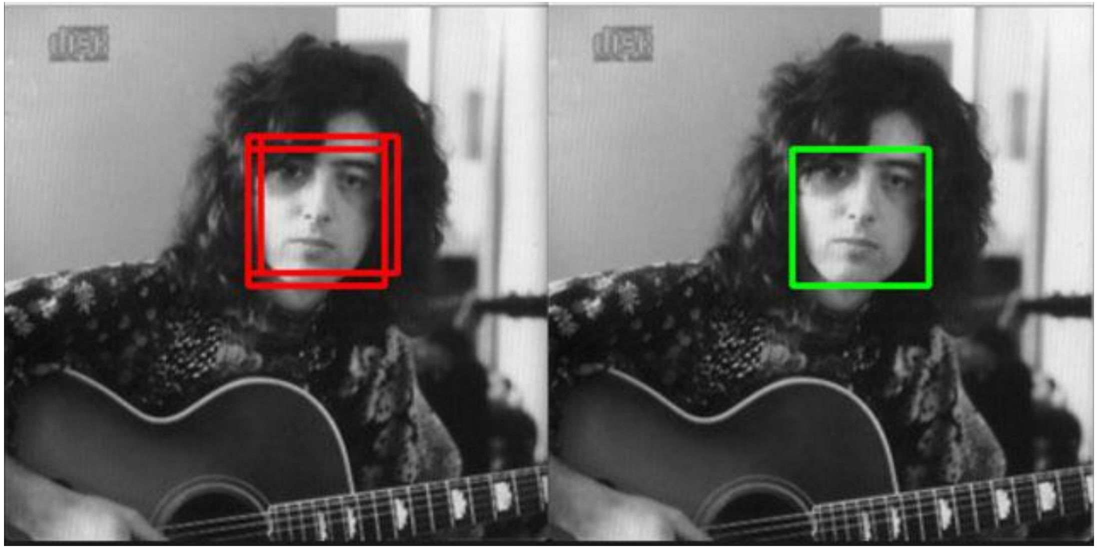


	AP	time
[A] YOLOv2† [8]	21.6	25
[B] SSD321 [9]	28.0	61
[C] DSSD321 [10]	28.0	85
[D] R-FCN‡ [11]	29.9	85
[E] SSD513 [9]	31.2	125
[F] DSSD513 [10]	33.2	156
[G] FPN FRCN [4]	36.2	172
RetinaNet-50-500	32.5	73
RetinaNet-101-500	34.4	90
RetinaNet-101-800	37.8	198

†Not plotted ‡Extrapolated time

Non-Maximum Suppression





You Only Look Once (YOLO)

YOLOv1-v2

Original Joseph Redmon slides from conferences

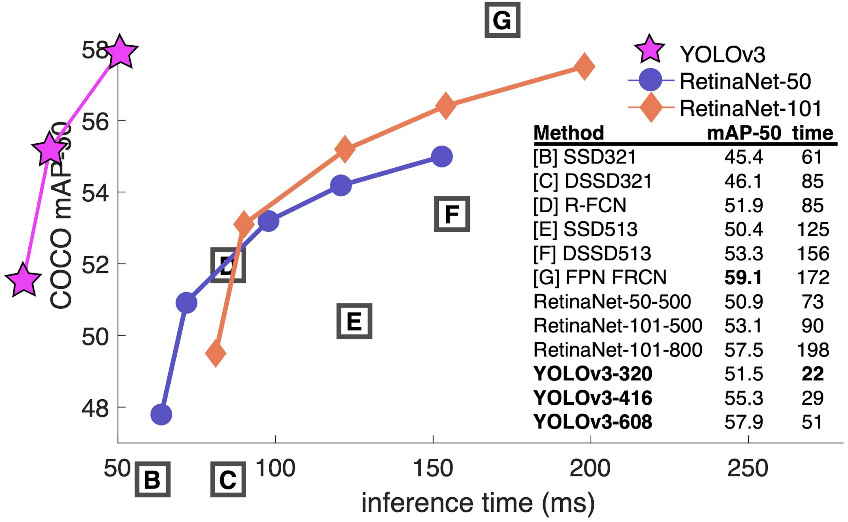
- YOLOv1
- YOLOv2

Also CVPR 2016 talk video

YOLOv3

- Bounding Box Prediction
- Class Prediction
- Predictions Across Scales
- Feature Extractor

All articles published on Joseph’s website



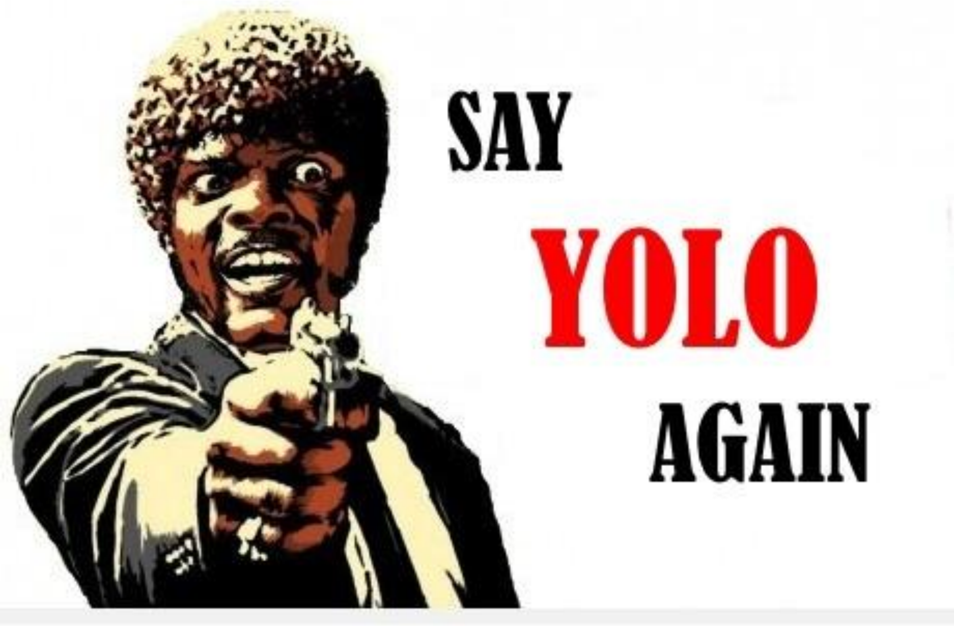
Method	mAP-50	time
[B] SSD321	45.4	61
[C] DSSD321	46.1	85
[D] R-FCN	51.9	85
[E] SSD513	50.4	125
[F] DSSD513	53.3	156
[G] FPN FRCN	**59.1**	172
RetinaNet-50-500	50.9	73
RetinaNet-101-500	53.1	90
RetinaNet-101-800	57.5	198
YOLOv3-320	51.5	**22**
YOLOv3-416	55.3	29
YOLOv3-608	57.9	51

Practical notes

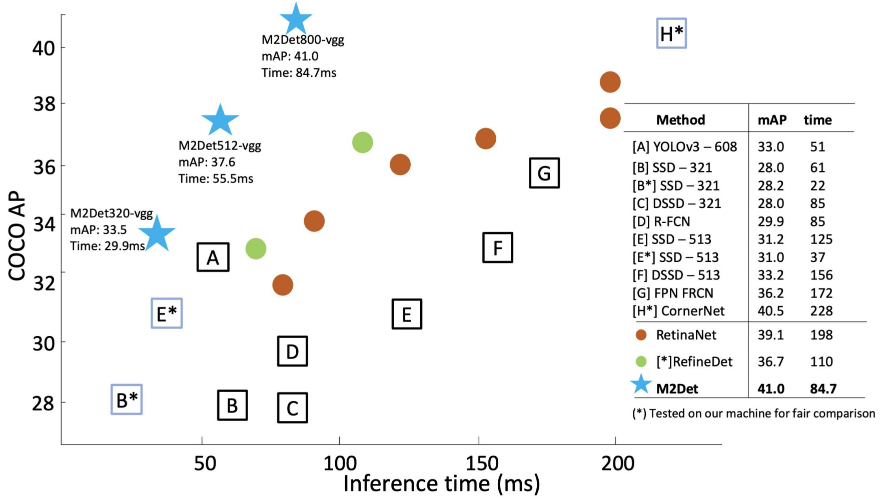
Write your own YOLO from scratch https://blog.paperspace.com/how-to-implement-a-yolo-object-detector-in-pytorch/

Original YOLO written on Darknet - custom NN framework

Weights import to TF via https://github.com/thtrieu/darkflow



Current state



Method	mAP	time
[A] YOLOv3 – 608	33.0	51
[B] SSD – 321	28.0	61
[B*] SSD – 321	28.2	22
[C] DSSD – 321	28.0	85
[D] R-FCN	29.9	85
[E] SSD – 513	31.2	125
[E*] SSD – 513	31.0	37
[F] DSSD – 513	33.2	156
[G] FPN FRCN	36.2	172
[H*] CornerNet	40.5	228
● RetinaNet	39.1	198
● [*]RefineDet	36.7	110
★ **M2Det**	**41.0**	**84.7**

(*) Tested on our machine for fair comparison

Figure 5: Speed (ms) vs. accuracy (mAP) on COCO *test-dev*.

M2Det: A Single-Shot Object Detector based on Multi-Level Feature Pyramid Network

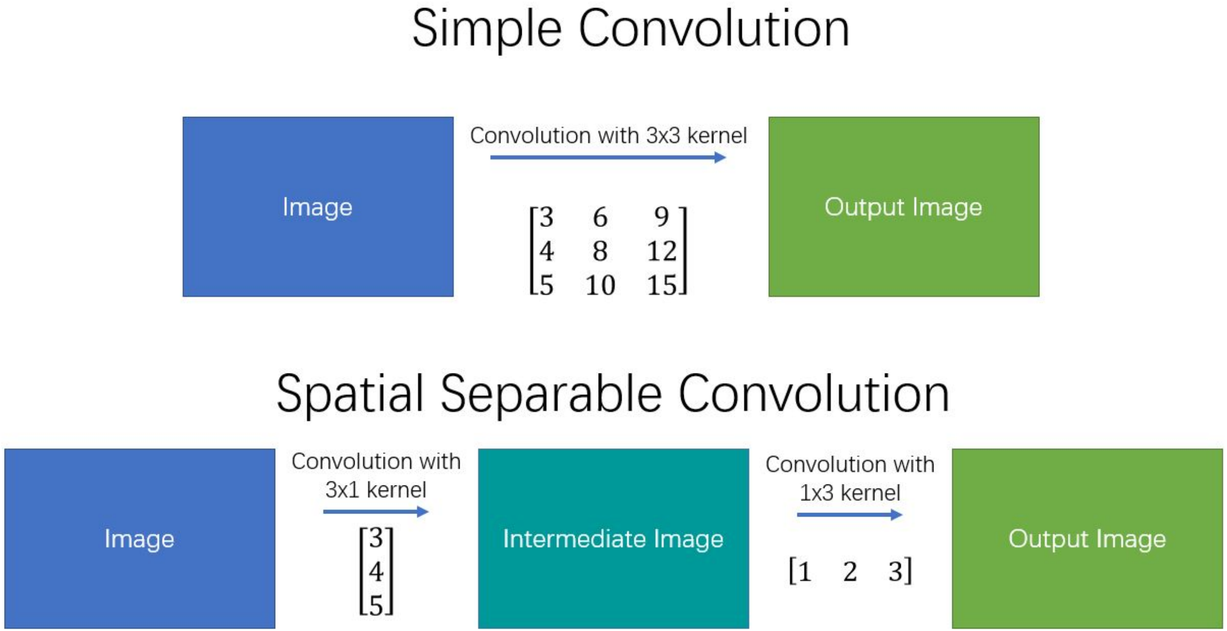
https://arxiv.org/pdf/1811.04533.pdf

Separable convs
MobileNet

Spatial Separable Convolution

$$\begin{bmatrix} 3 & 6 & 9 \\ 4 & 8 & 12 \\ 5 & 10 & 15 \end{bmatrix} = \begin{bmatrix} 3 \\ 4 \\ 5 \end{bmatrix} \times \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}$$

Spatial Separable Convolution



Simple Convolution

Image

Convolution with 3x3 kernel

$$\begin{bmatrix} 3 & 6 & 9 \\ 4 & 8 & 12 \\ 5 & 10 & 15 \end{bmatrix}$$

Output Image

Spatial Separable Convolution

Image

Convolution with 3x1 kernel

$$\begin{bmatrix} 3 \\ 4 \\ 5 \end{bmatrix}$$

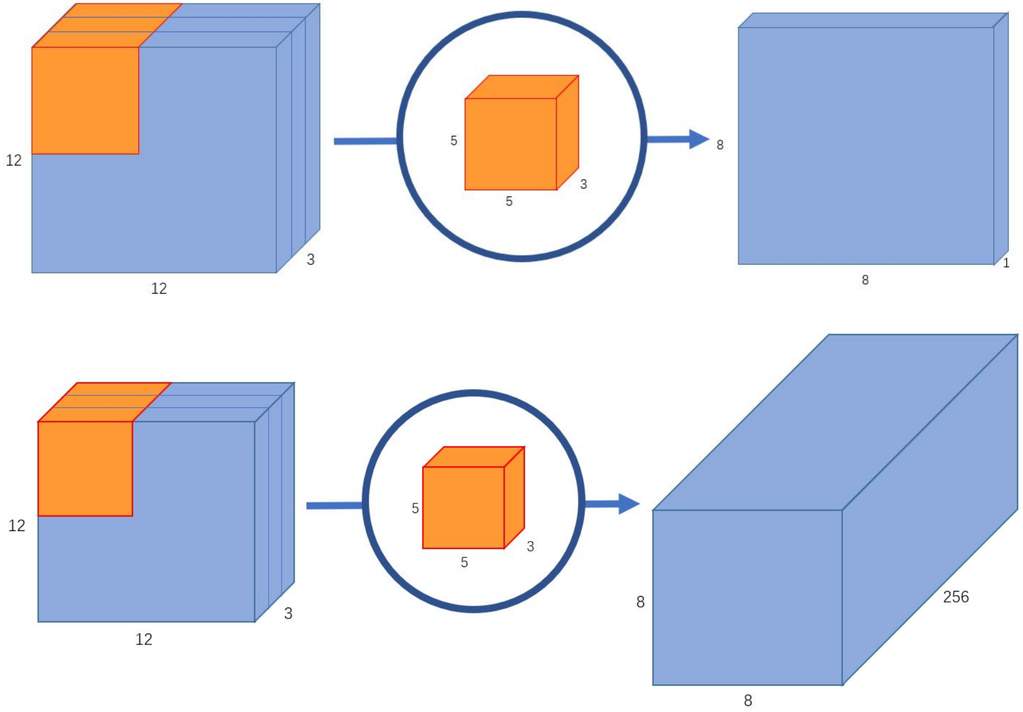
Intermediate Image

Convolution with 1x3 kernel

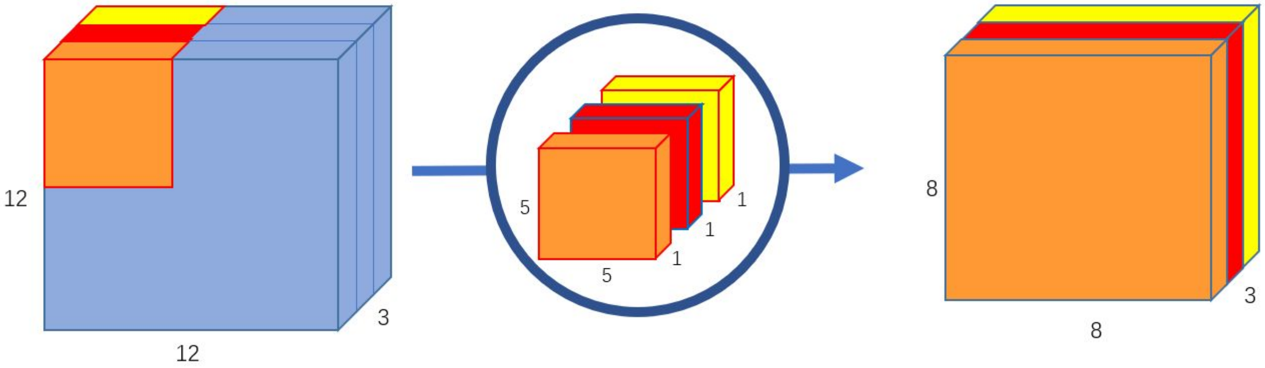
$$\begin{bmatrix} 1 & 2 & 3 \end{bmatrix}$$

Output Image

Normal Convolution

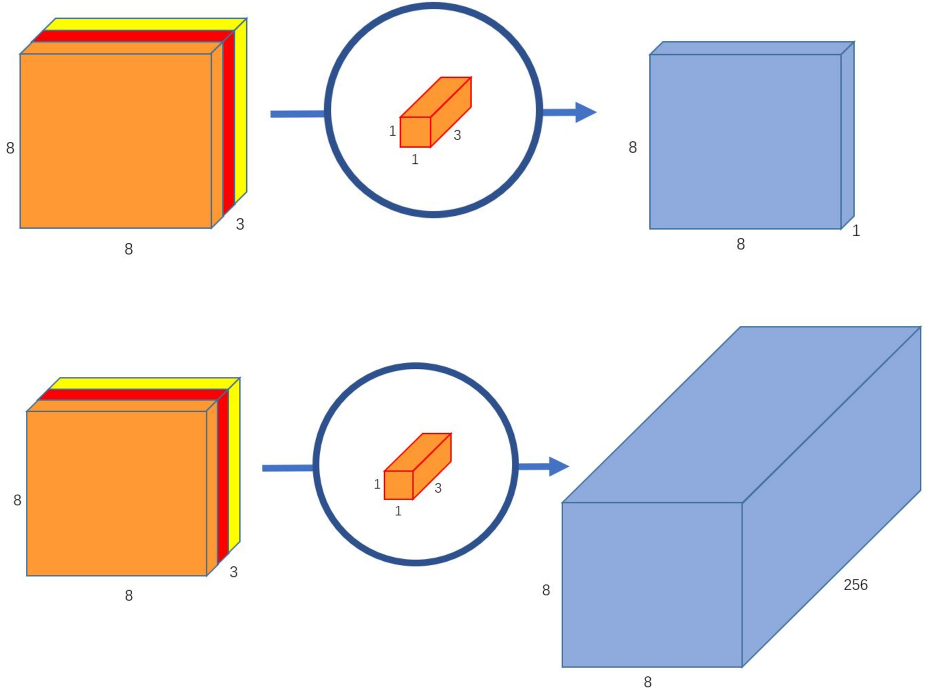


Depthwise Convolution

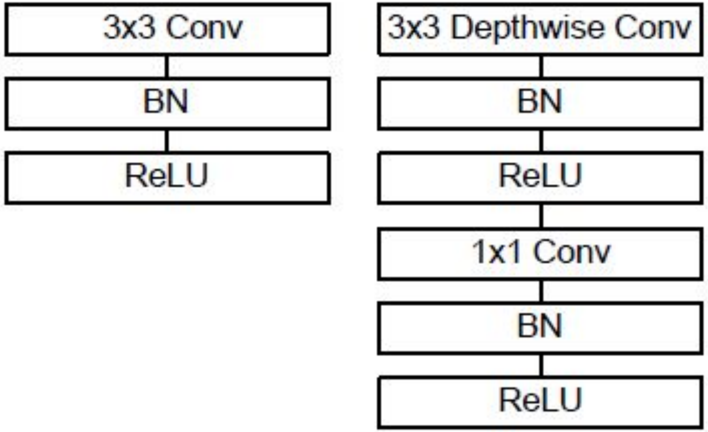


Don’t change channels number

Pointwise Convolution



MobileNet v1



3x3 Conv

BN

ReLU

3x3 Depthwise Conv

BN

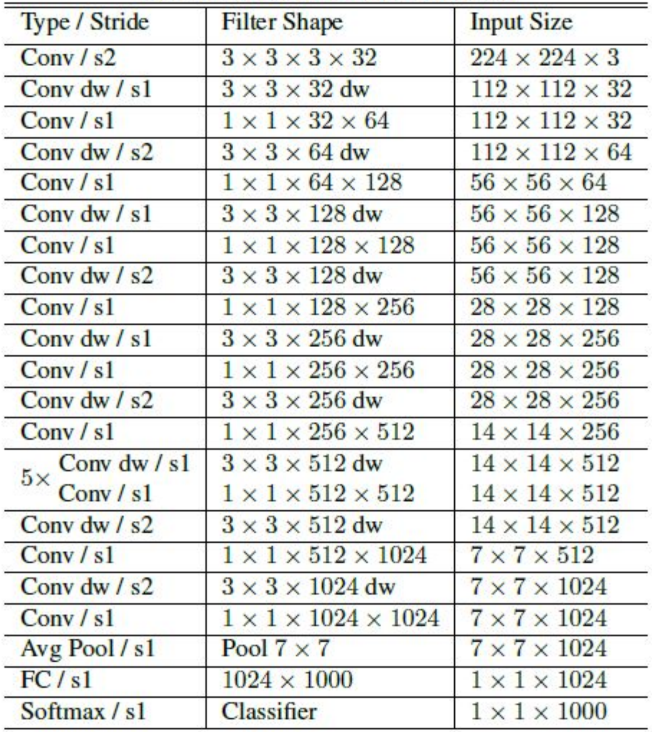
ReLU

1x1 Conv

BN

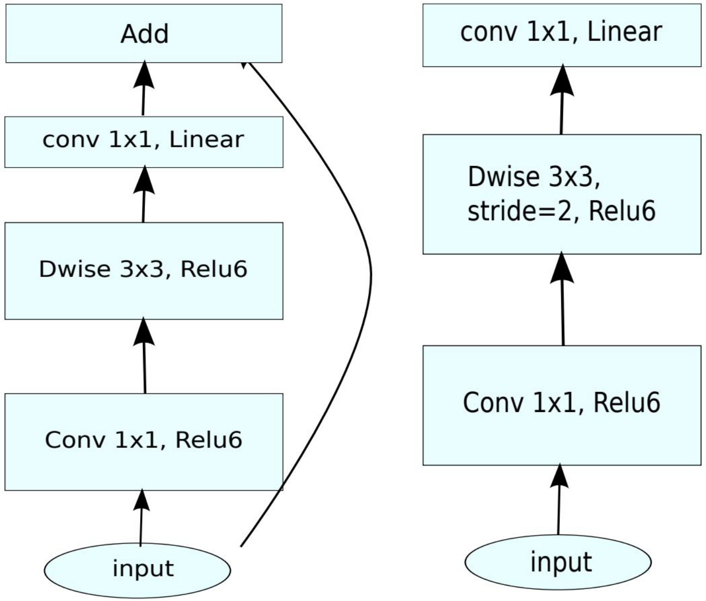
ReLU

Table 1. MobileNet Body Architecture



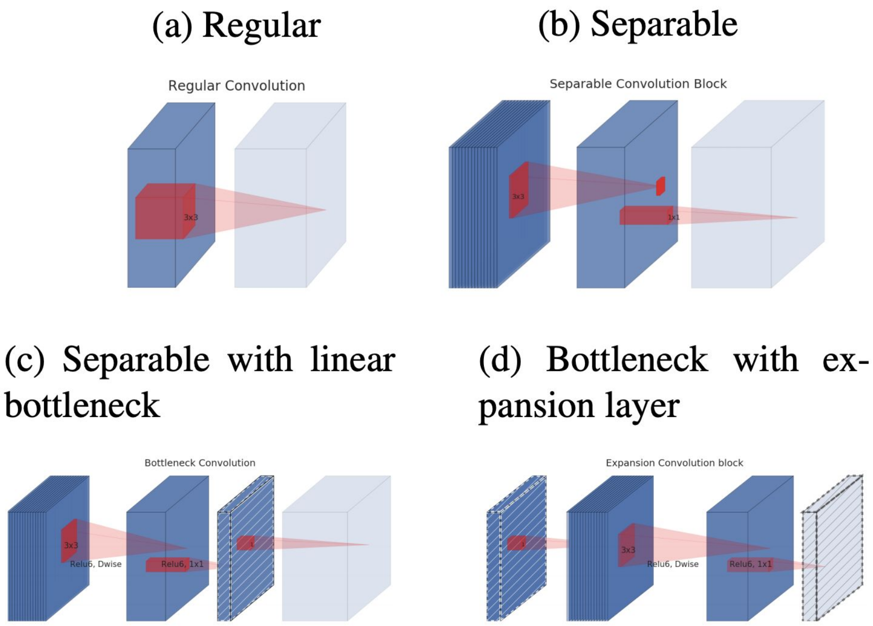
Type / Stride	Filter Shape	Input Size
Conv / s2	$3 \times 3 \times 3 \times 32$	$224 \times 224 \times 3$
Conv dw / s1	$3 \times 3 \times 32$ dw	$112 \times 112 \times 32$
Conv / s1	$1 \times 1 \times 32 \times 64$	$112 \times 112 \times 32$
Conv dw / s2	$3 \times 3 \times 64$ dw	$112 \times 112 \times 64$
Conv / s1	$1 \times 1 \times 64 \times 128$	$56 \times 56 \times 64$
Conv dw / s1	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 128$	$56 \times 56 \times 128$
Conv dw / s2	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 256$	$28 \times 28 \times 128$
Conv dw / s1	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 256$	$28 \times 28 \times 256$
Conv dw / s2	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 512$	$14 \times 14 \times 256$
5× Conv dw / s1 Conv / s1	$3 \times 3 \times 512$ dw $1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$ $14 \times 14 \times 512$
Conv dw / s2	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv / s1	$1 \times 1 \times 512 \times 1024$	$7 \times 7 \times 512$
Conv dw / s2	$3 \times 3 \times 1024$ dw	$7 \times 7 \times 1024$
Conv / s1	$1 \times 1 \times 1024 \times 1024$	$7 \times 7 \times 1024$
Avg Pool / s1	Pool 7×7	$7 \times 7 \times 1024$
FC / s1	1024×1000	$1 \times 1 \times 1024$
Softmax / s1	Classifier	$1 \times 1 \times 1000$

MobileNet v2



Stride=1 block

Stride=2 block

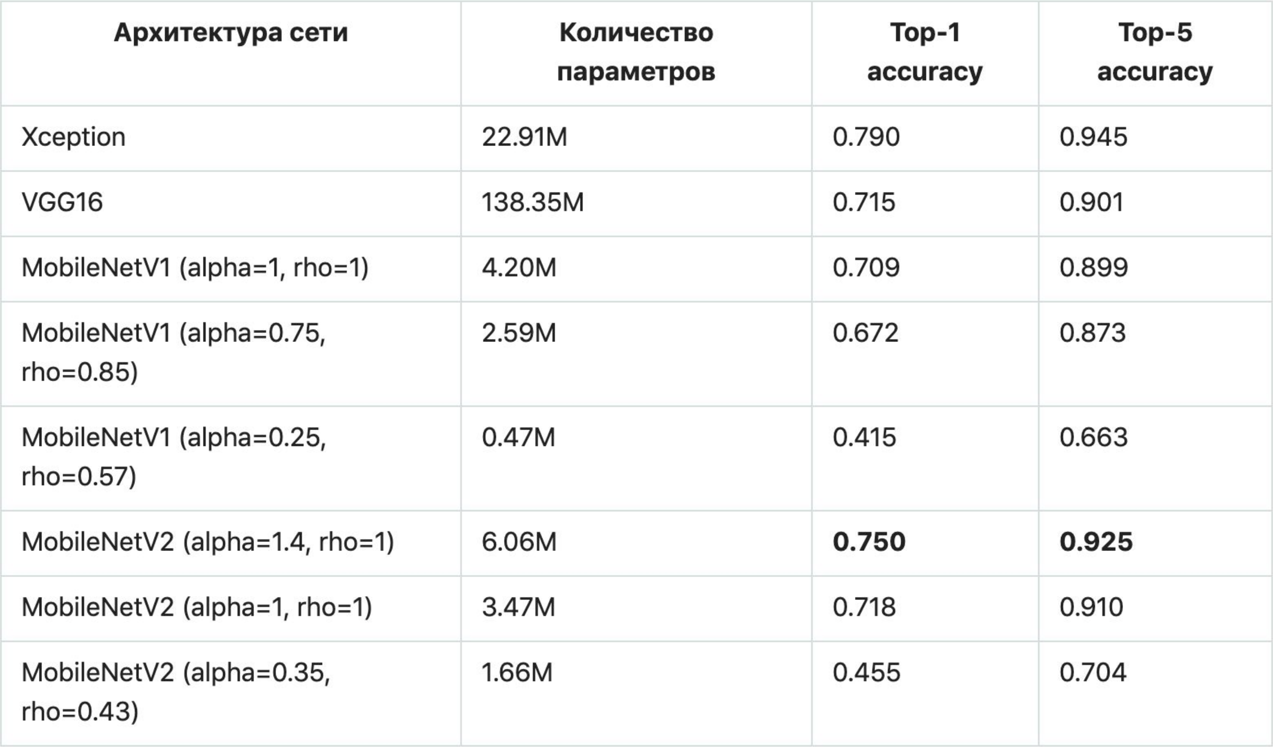

(a) Regular

(b) Separable

(c) Separable with linear bottleneck

(d) Bottleneck with expansion layer

Results



Архитектура сети	Количество параметров	Top-1 accuracy	Top-5 accuracy
Xception	22.91M	0.790	0.945
VGG16	138.35M	0.715	0.901
MobileNetV1 (alpha=1, rho=1)	4.20M	0.709	0.899
MobileNetV1 (alpha=0.75, rho=0.85)	2.59M	0.672	0.873
MobileNetV1 (alpha=0.25, rho=0.57)	0.47M	0.415	0.663
MobileNetV2 (alpha=1.4, rho=1)	6.06M	**0.750**	**0.925**
MobileNetV2 (alpha=1, rho=1)	3.47M	0.718	0.910
MobileNetV2 (alpha=0.35, rho=0.43)	1.66M	0.455	0.704

Revise

- Recap
- Focal Loss
- Non-Maximum Suppression
- YOLO
  - v1
  - v2
  - V3
- Separable convolutions
- MobileNet

Next time

- Segmentation

See Mask R-CNN ICCV17 talk to prepare yourself