



VietAI

# Convolutional Neural Networks (cont.)

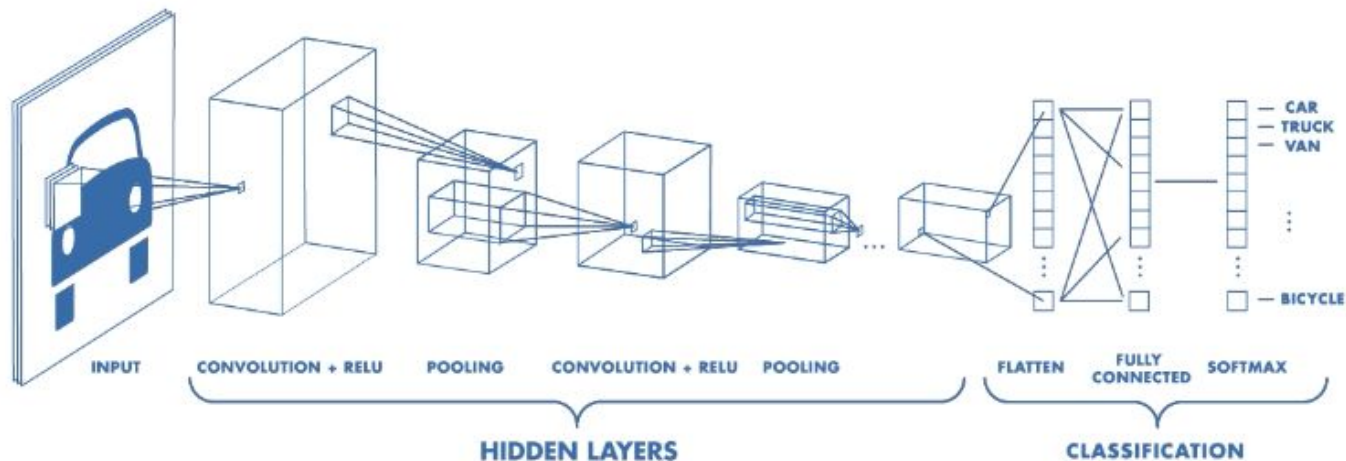


VietAI Teaching Team

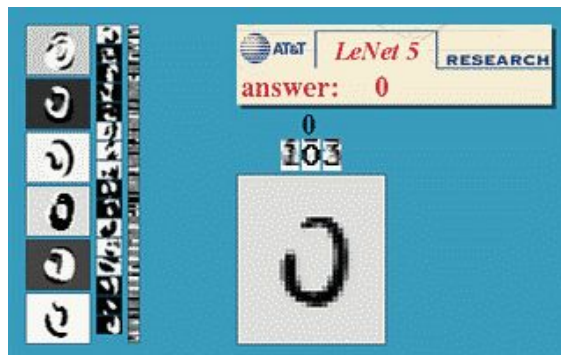
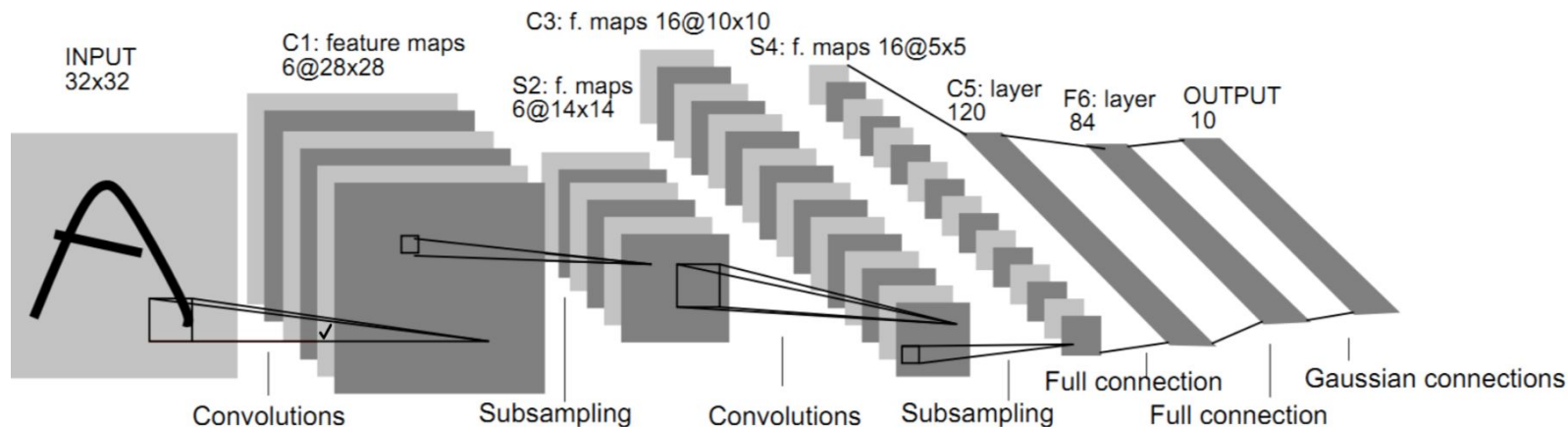
# Nội dung

1. Nhắc lại CNN
2. Một số kiến trúc CNN và đặc điểm
  - a) Sự phát triển của CNN
  - b) AlexNet
  - c) ZFNet
  - d) VGGNet
  - e) GoogLeNet
  - f) ResNet
  - g) DenseNet
3. Transfer Learning

# 1 Nhắc lại CNN - Kiến trúc phổ dụng

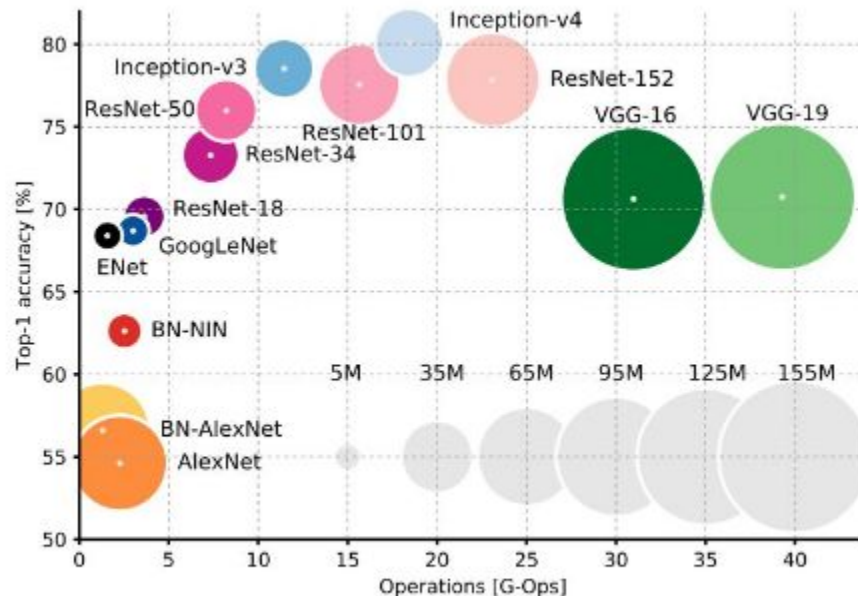
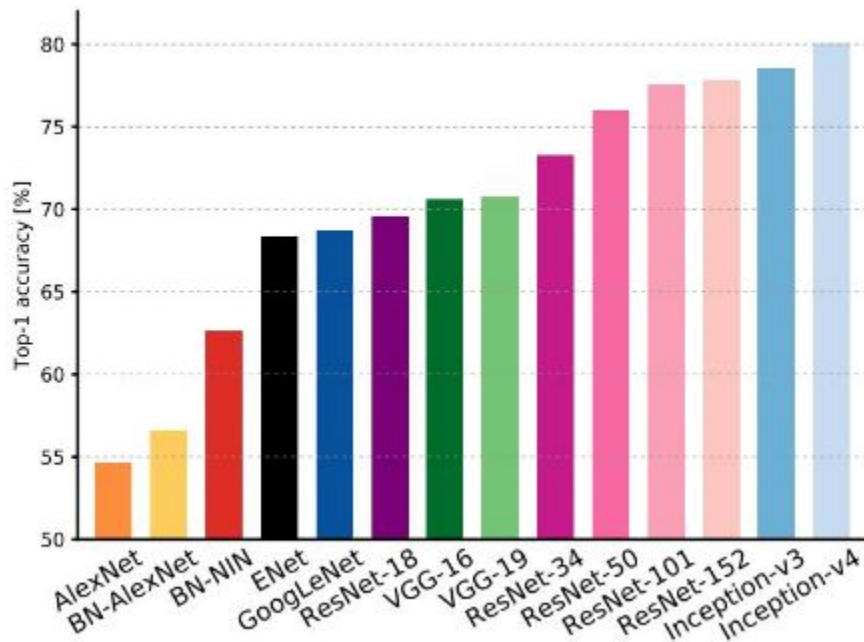


## 2 Sự phát triển của CNN - LeNet-5





## 2 Sự phát triển của CNN



An Analysis of Deep Neural Network Models for Practical Applications, 2017.

## 2 Sự phát triển của CNN - Cách so sánh

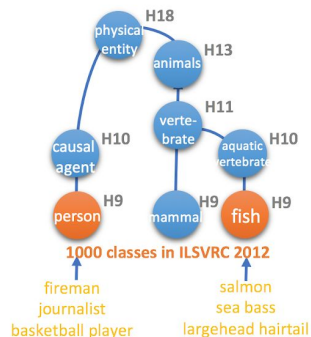
### IMAGENET

*ImageNet Large Scale Visual Recognition Challenge (ILSVRC)*

- > 14M ảnh
- > 20K class

Tổ chức cuộc thi thường niên từ 2010  
+ Classification  
+ Detection

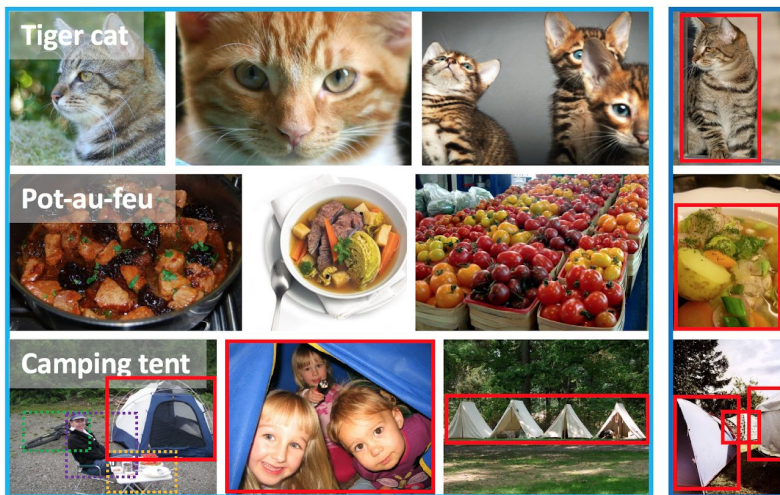
WordNet Class Hierarchy



The extended classes beyond ILSVRC 2012

- Ground truth (provided or annotated)
- Training set (2686 classes)
- Test set (1/10 amount of training)

Extended ImageNet Classification Dataset (EIC)



# Nội dung

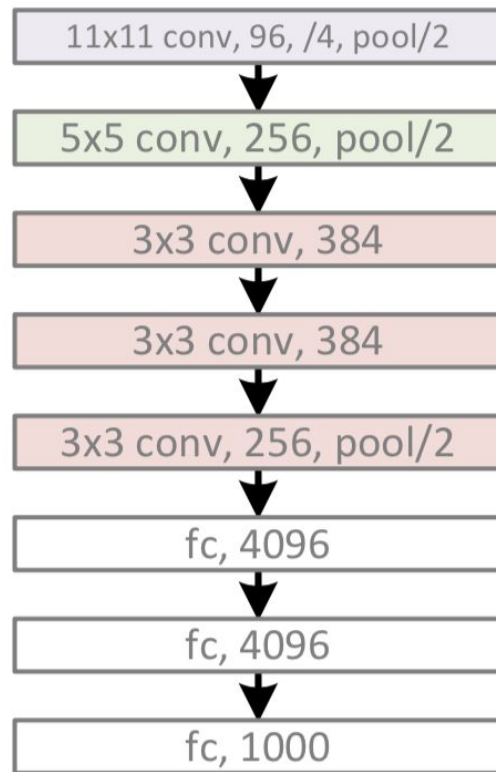
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## 2 AlexNet – ILSVRC 2012 Winner

Đặc trưng:

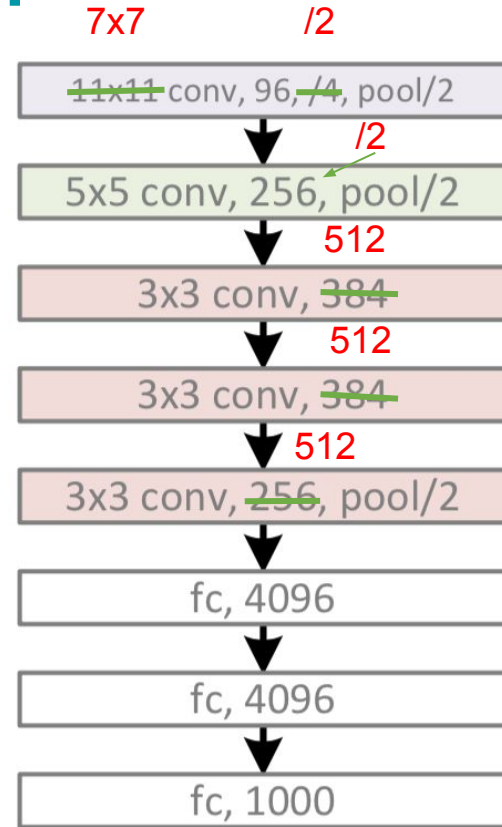
- ReLU activation
- Dropout



## 2 ZFNet – ILSVRC 2013 Winner

Đặc trưng:

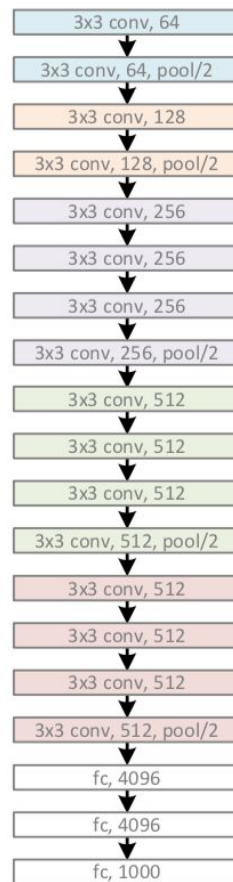
- Dựa trên AlexNet
- Sử dụng kernels cỡ nhỏ



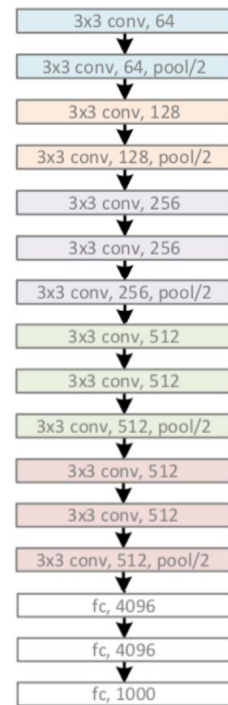
## 2 VGGNet – ILSVRC 2014 1st Runner Up

Đặc trưng:

- Sử dụng conv 3x3
  - receptive field hiệu quả
  - số lượng trọng số ít hơn (3 filter 3x3 với 1 filter 7x7)
- Dễ dàng “lắp” thêm module:  
VGG11 -> VGG13 -> VGG16 -> VGG19
- Số lượng parameters lớn: VGG16 - 138M



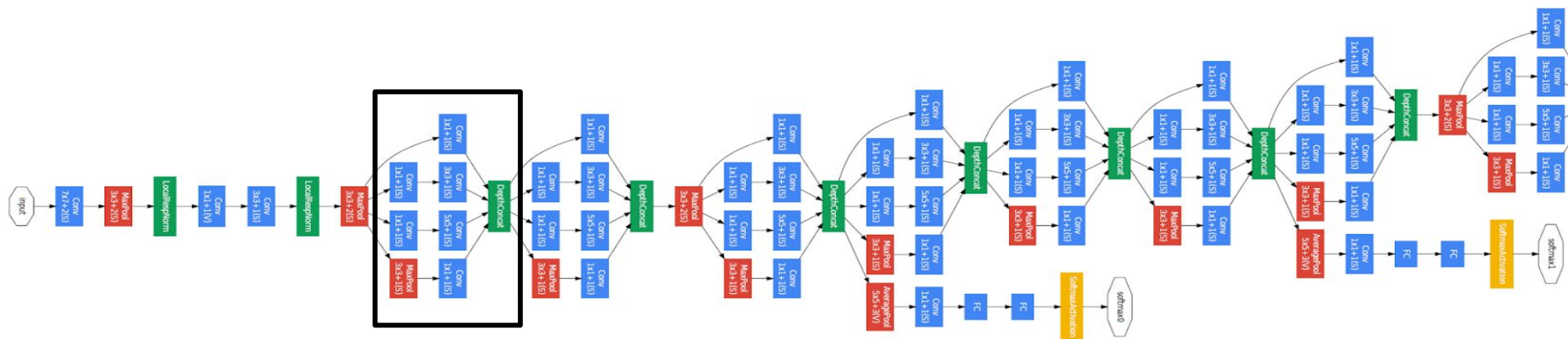
**VGG19**



**VGG16**

2

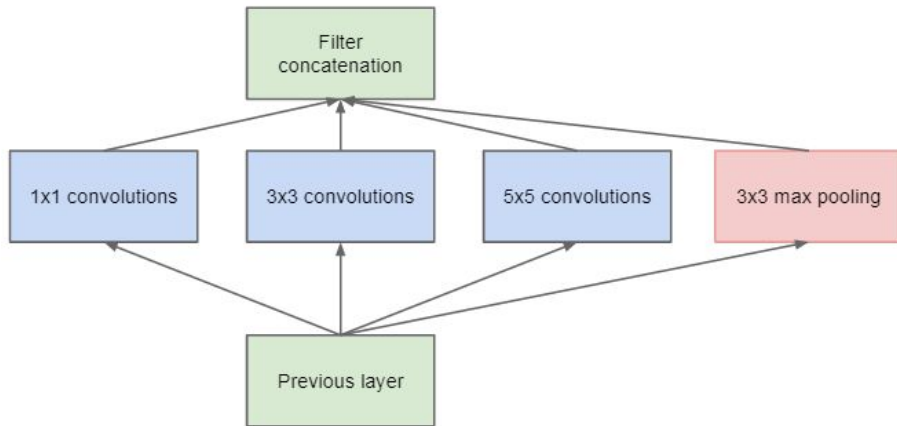
# GoogLeNet - ILSVRC 2014 Winner



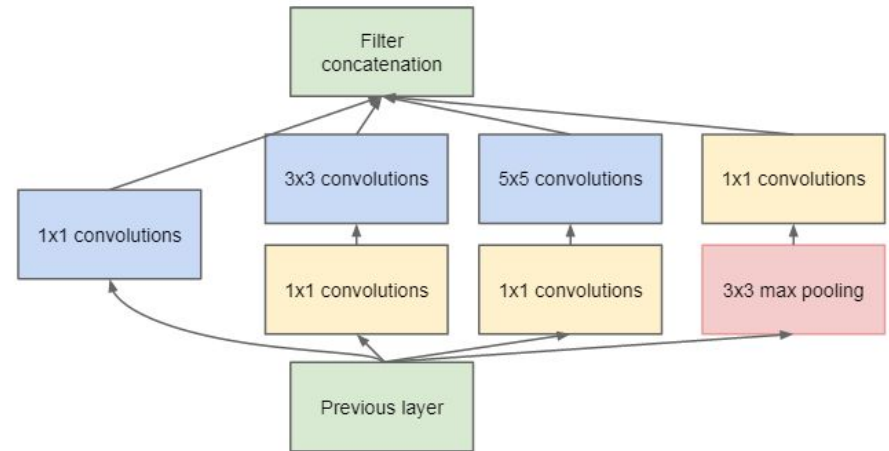
Đặc trưng:

- Các Inception modules
- Batch normalization
- Auxiliary classifiers

## 2 GoogLeNet - Inception Module



(a) Inception module, naïve version

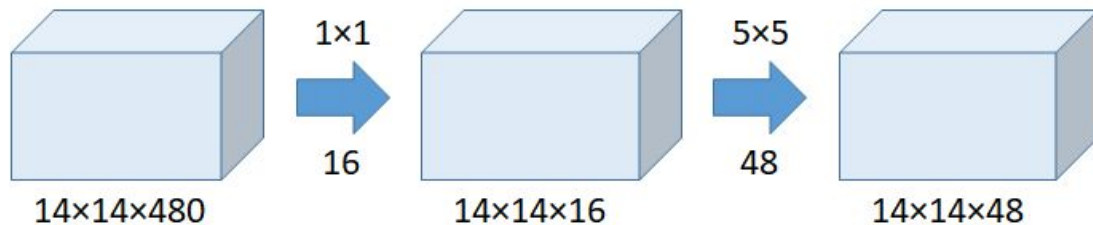
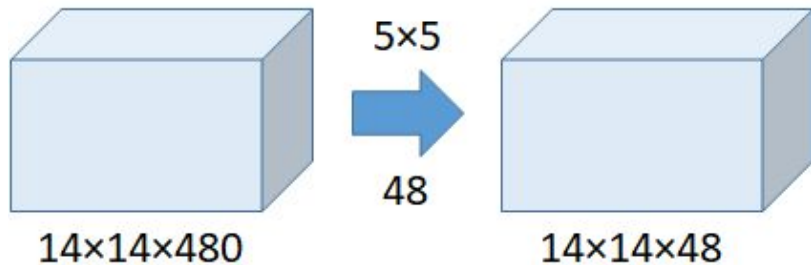


(b) Inception module with dimension reductions

Đặc điểm của inception module:

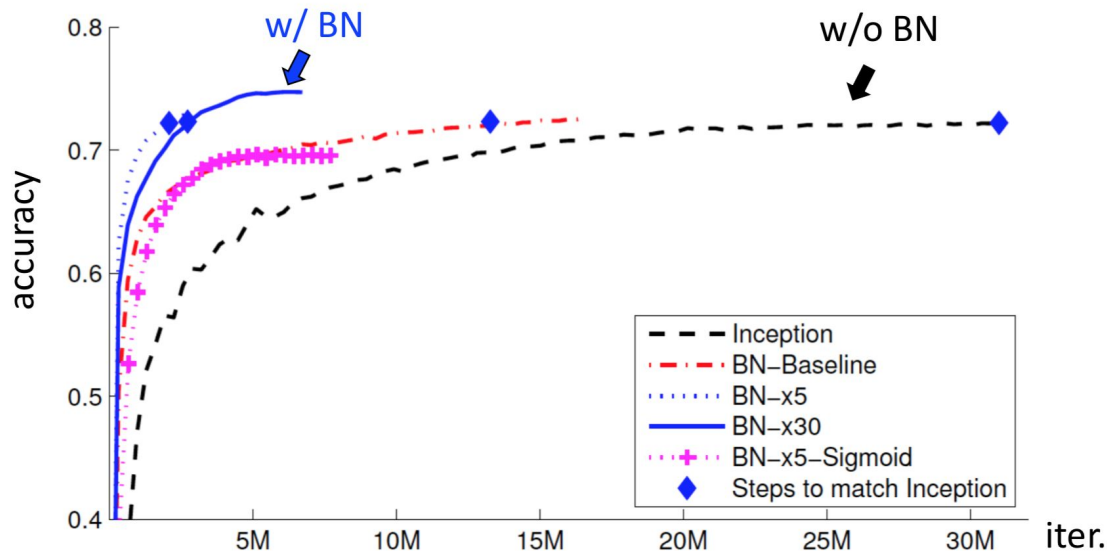
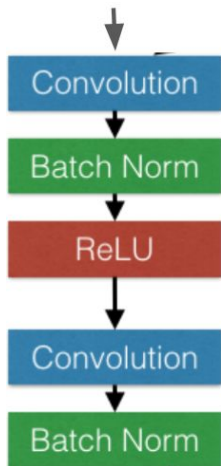
- Sparsely connected do lớp pooling
- Kernels nhiều size cho cùng convolutional layer: 1x1, 3x3, 5x5
- Giảm computational cost

## 2 GoogLeNet - Computational Cost



## 2 GoogLeNet - Batch Normalization

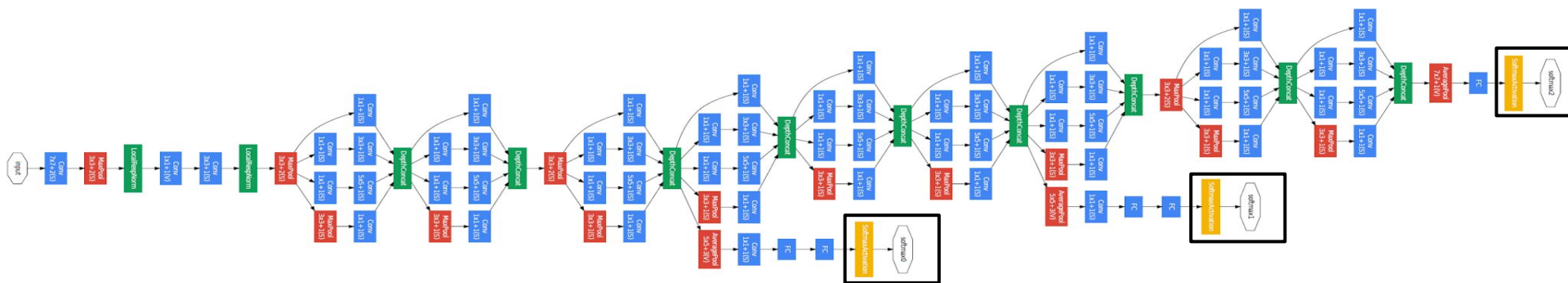
Áp dụng Normalizing input cho mỗi layer và normalize theo trên cả mini-batch.



BN giúp tăng tốc quá trình training, giúp mạng ít nhạy cảm hơn với tham số khởi đầu và góp phần làm regularization

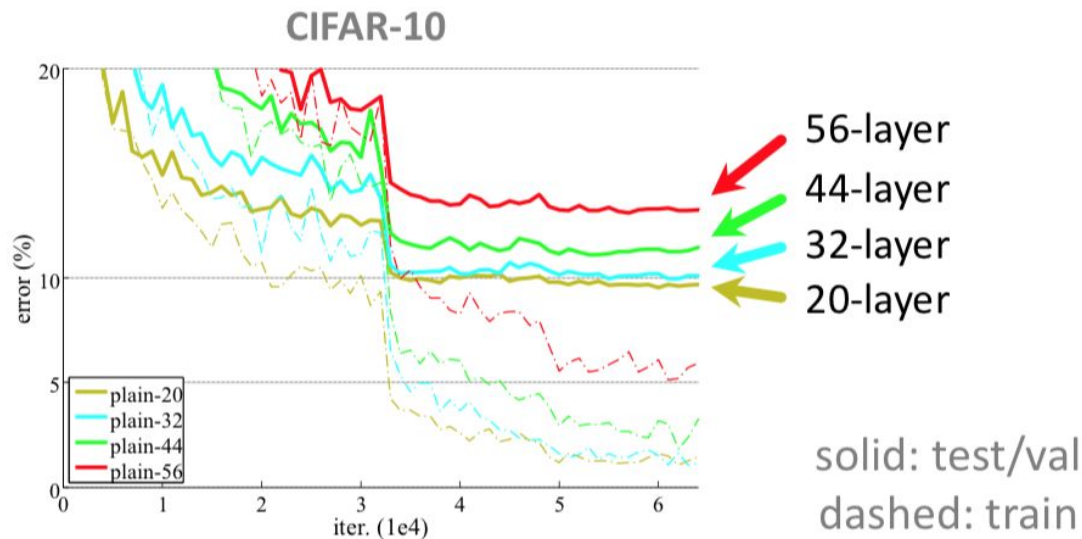
2

# GoogLeNet - Auxiliary Classifiers



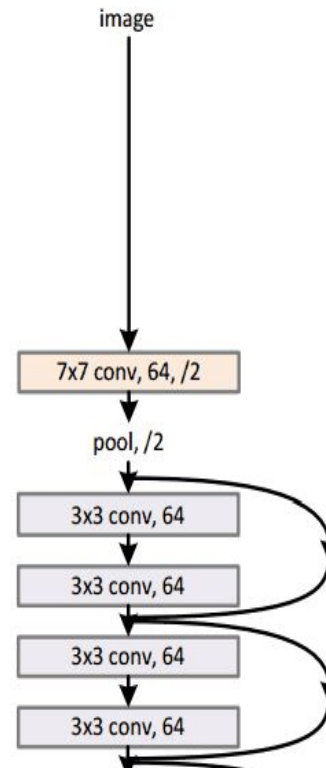


## 2 ResNet - ILSVRC 2015 Winner



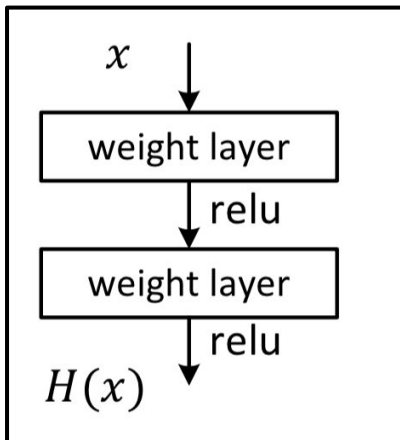
Đơn thuần xếp chồng thêm các layers

34-layer residual

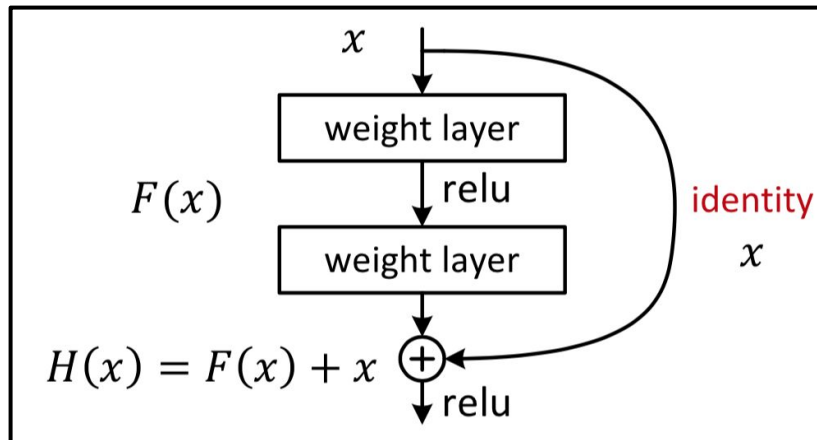


## 2 ResNet - Skip Connections

Plain net



Residual net



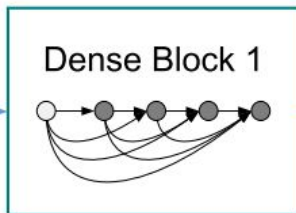
2

# DenseNet

Input

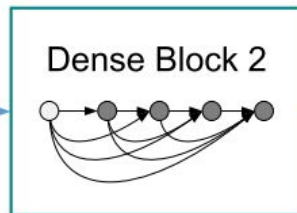


Convolution



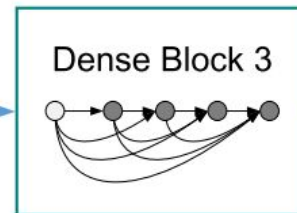
Convolution

Pooling



Convolution

Pooling



Pooling

Linear

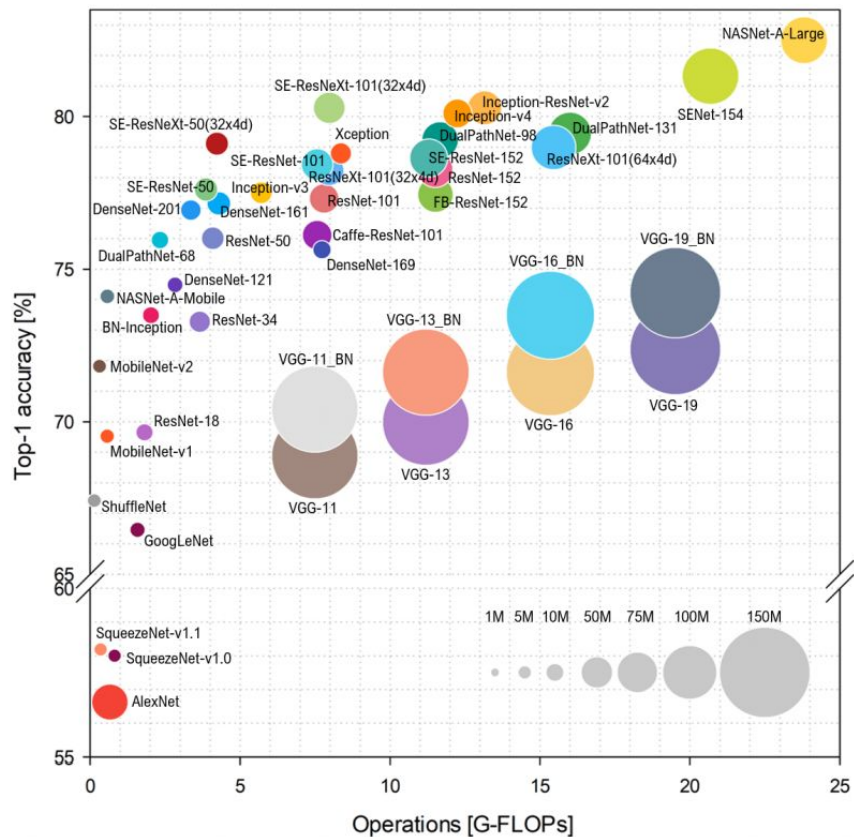
Prediction

"horse"



- Shortcut connection nối mọi layers trước đó đến layer sau (Densely connected)
- Concat các lớp

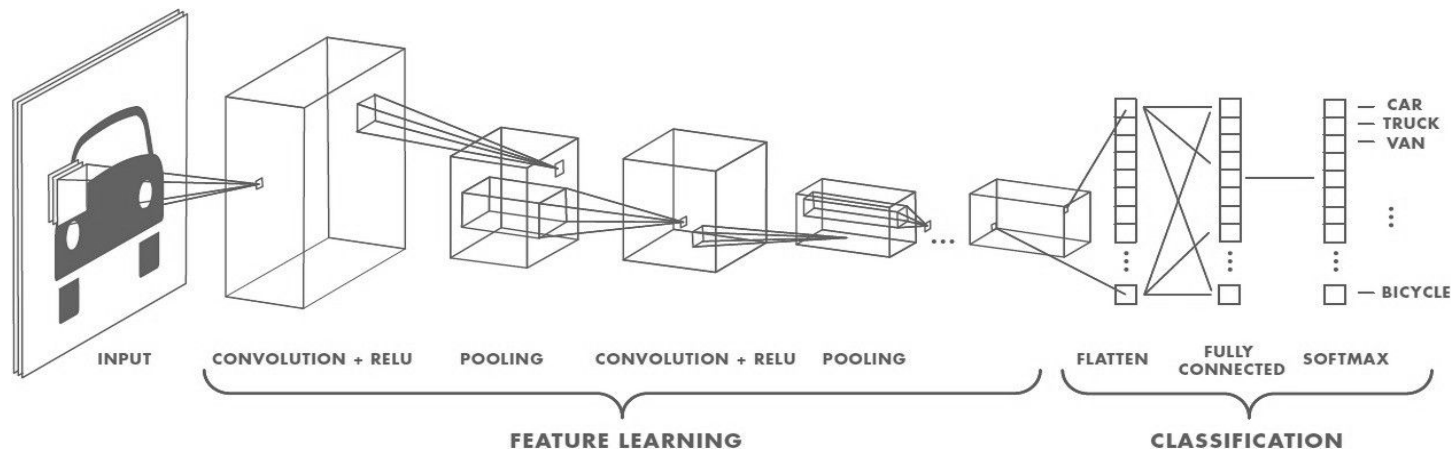
## 2 Các kiến trúc CNN



Model	Size	Top-1 Accuracy	Top-5 Accuracy	Parameters	Depth
Xception	88 MB	0.790	0.945	22,910,480	126
VGG16	528 MB	0.713	0.901	138,357,544	23
VGG19	549 MB	0.713	0.900	143,667,240	26
ResNet50	98 MB	0.749	0.921	25,636,712	-
ResNet101	171 MB	0.764	0.928	44,707,176	-
ResNet152	232 MB	0.766	0.931	60,419,944	-
ResNet50V2	98 MB	0.760	0.930	25,613,800	-
ResNet101V2	171 MB	0.772	0.938	44,675,560	-
ResNet152V2	232 MB	0.780	0.942	60,380,648	-
ResNeXt50	96 MB	0.777	0.938	25,097,128	-
ResNeXt101	170 MB	0.787	0.943	44,315,560	-
InceptionV3	92 MB	0.779	0.937	23,851,784	159
InceptionResNetV2	215 MB	0.803	0.953	55,873,736	572
MobileNet	16 MB	0.704	0.895	4,253,864	88
MobileNetV2	14 MB	0.713	0.901	3,538,984	88
DenseNet121	33 MB	0.750	0.923	8,062,504	121
DenseNet169	57 MB	0.762	0.932	14,307,880	169
DenseNet201	80 MB	0.773	0.936	20,242,984	201
NASNetMobile	23 MB	0.744	0.919	5,326,716	-
NASNetLarge	343 MB	0.825	0.960	88,949,818	-

### 3 Transfer Learning

- Dùng pretrained model để huấn luyện mô hình.
- Ví dụ: freeze weights của tất cả lớp trước, chỉ train lại lớp cuối.



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# Tài liệu tham khảo

1. Asifullah Khan et al. (2019). A Survey of the Recent Architectures of Deep Convolutional Neural Networks
2. [Simone Bianco et al. \(2018\). Benchmark Analysis of Representative Deep Neural Network Architectures](#)
3. <https://keras.io/applications/>
4. Stanford CS231n (2018)
5. UoT CSC2523 Deep Learning in Computer Vision course (2018)