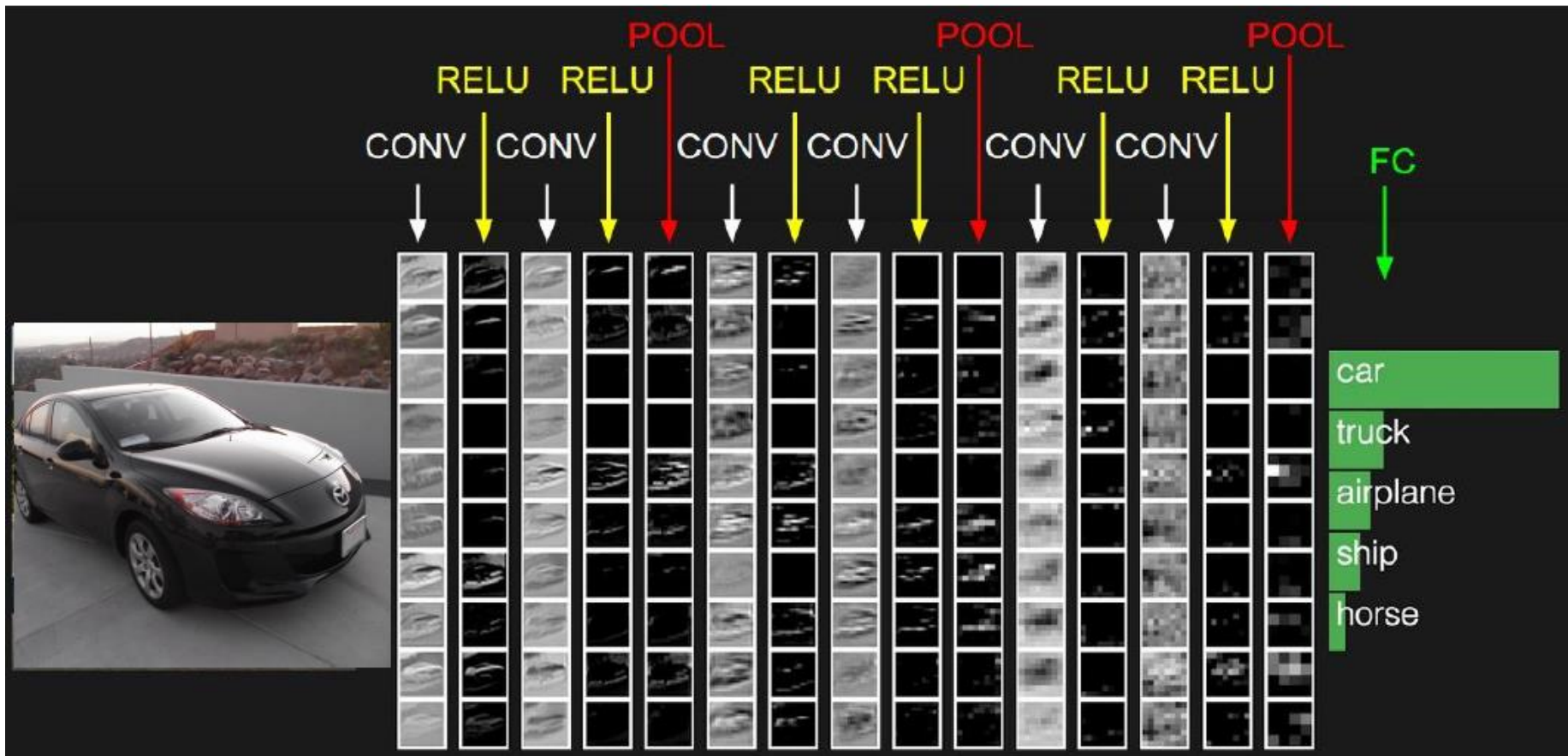


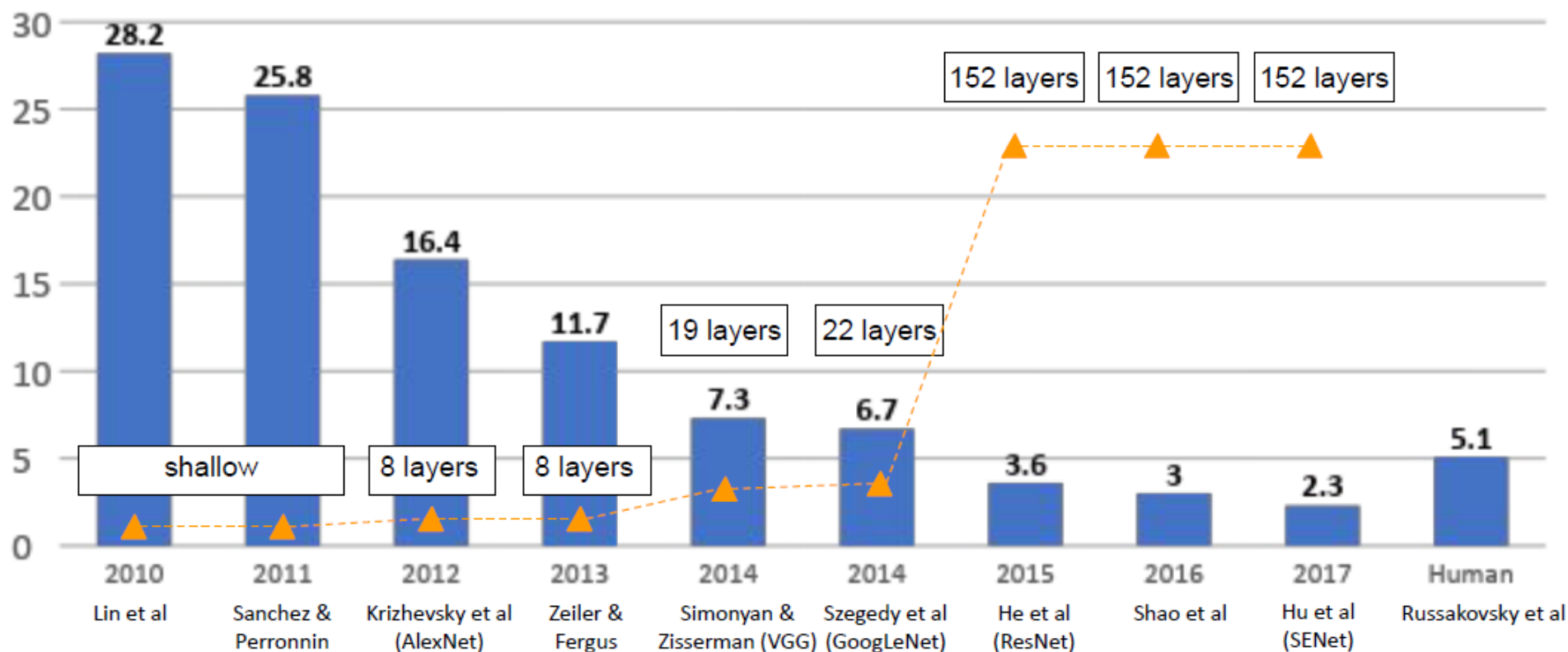
CNN 아키텍처



ImageNet

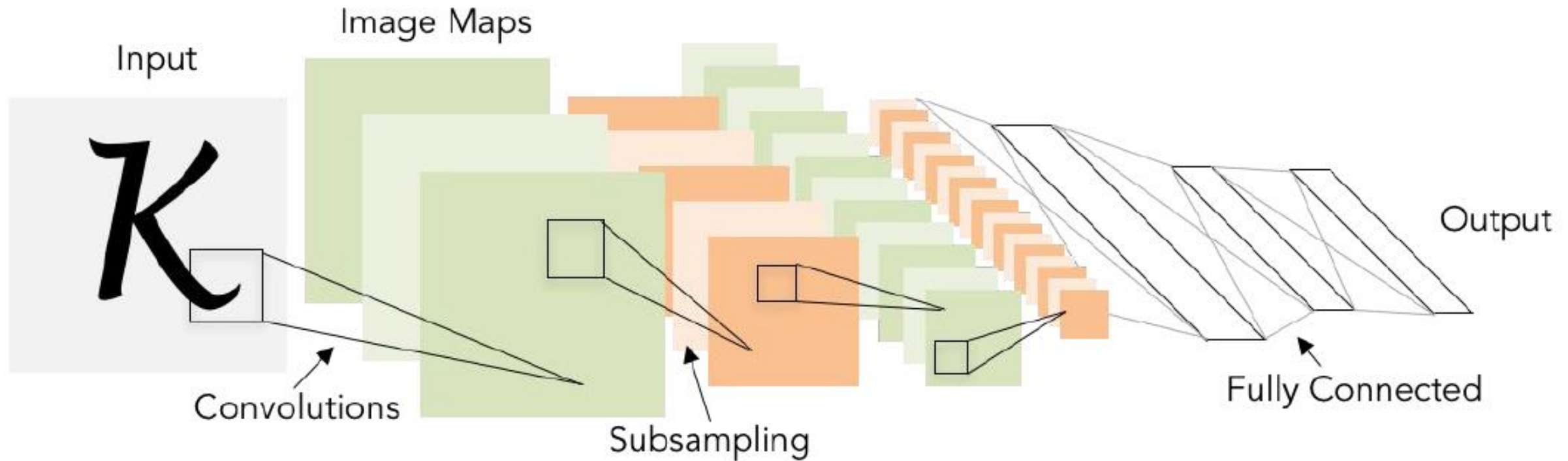
이미지 분류 모델을 측정하기 위한 데이터셋, 학습데이터셋 138G, 2만개 이상의 클래스, 약 1,400만장의 이미지

ImageNet Large Scale Visual Recognition Challenge (ILSVRC) winners



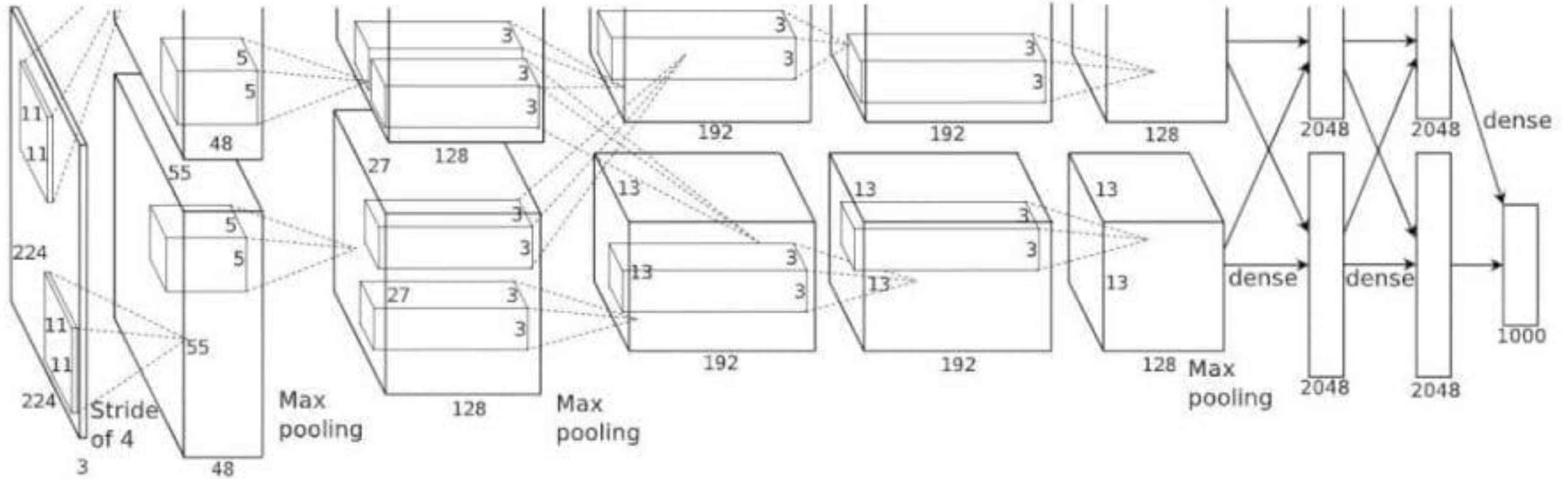
LeNet-5

[LeCun et al., 1998]

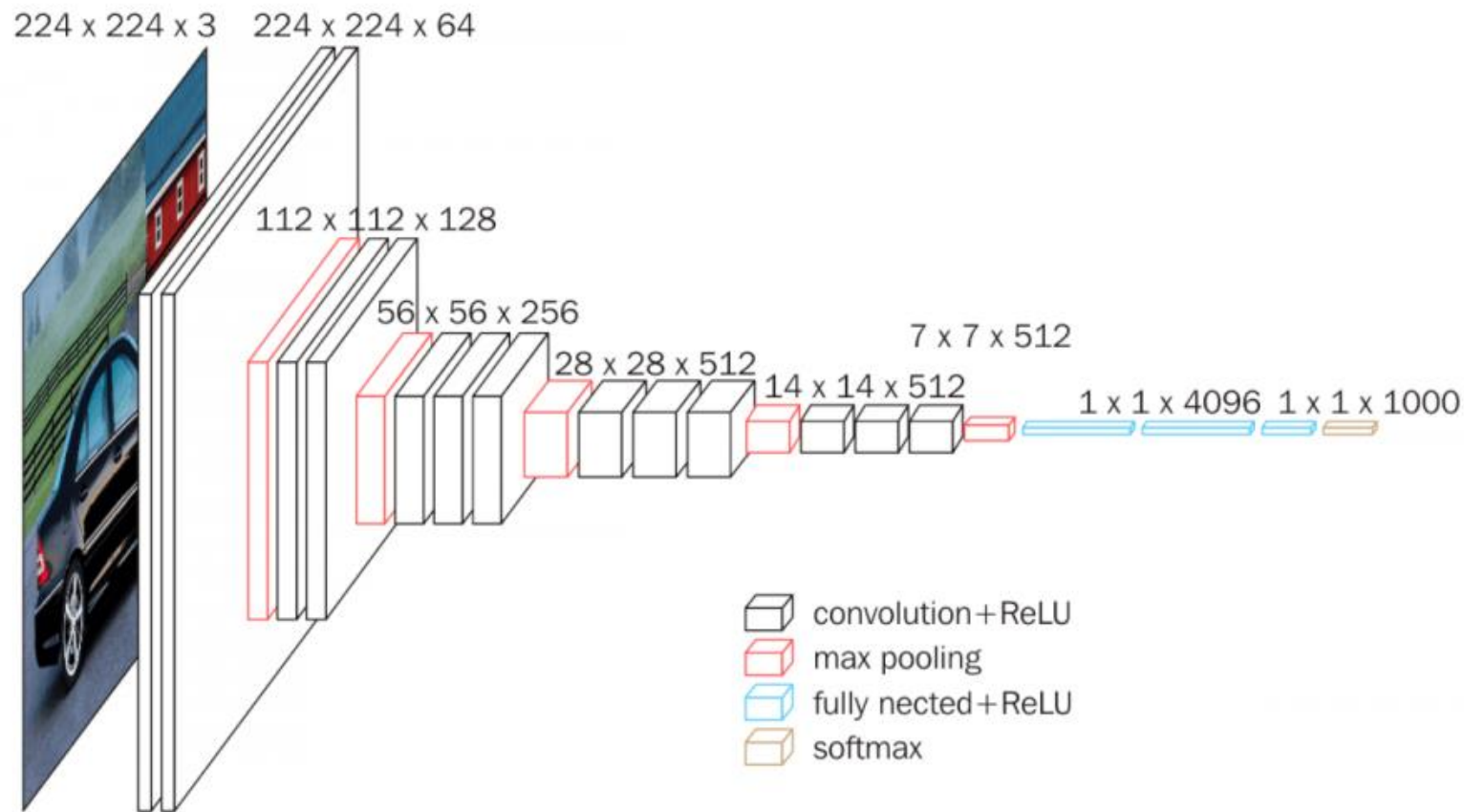


Conv filters were 5x5, applied at stride 1
Subsampling (Pooling) layers were 2x2 applied at stride 2
i.e. architecture is [CONV-POOL-CONV-POOL-FC-FC]

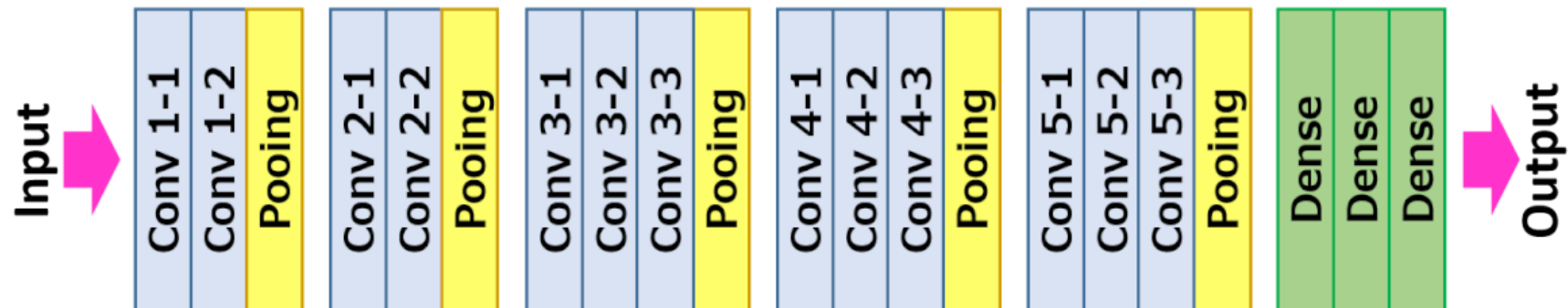
AlexNet



VGG



VGG-16



ConvNet Configuration					
A	A-LRN	B	C	D	E
11 weight layers	11 weight layers	13 weight layers	16 weight layers	16 weight layers	19 weight layers
input (224 × 224 RGB image)					
conv3-64	conv3-64 LRN	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 conv3-128	conv3-128 conv3-128	conv3-128 conv3-128	conv3-128 conv3-128
maxpool					
conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256 conv1-256	conv3-256 conv3-256 conv3-256	conv3-256 conv3-256 conv3-256 conv3-256
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 conv1-512	conv3-512 conv3-512 conv3-512	conv3-512 conv3-512 conv3-512 conv3-512
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 conv1-512	conv3-512 conv3-512 conv3-512	conv3-512 conv3-512 conv3-512 conv3-512
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

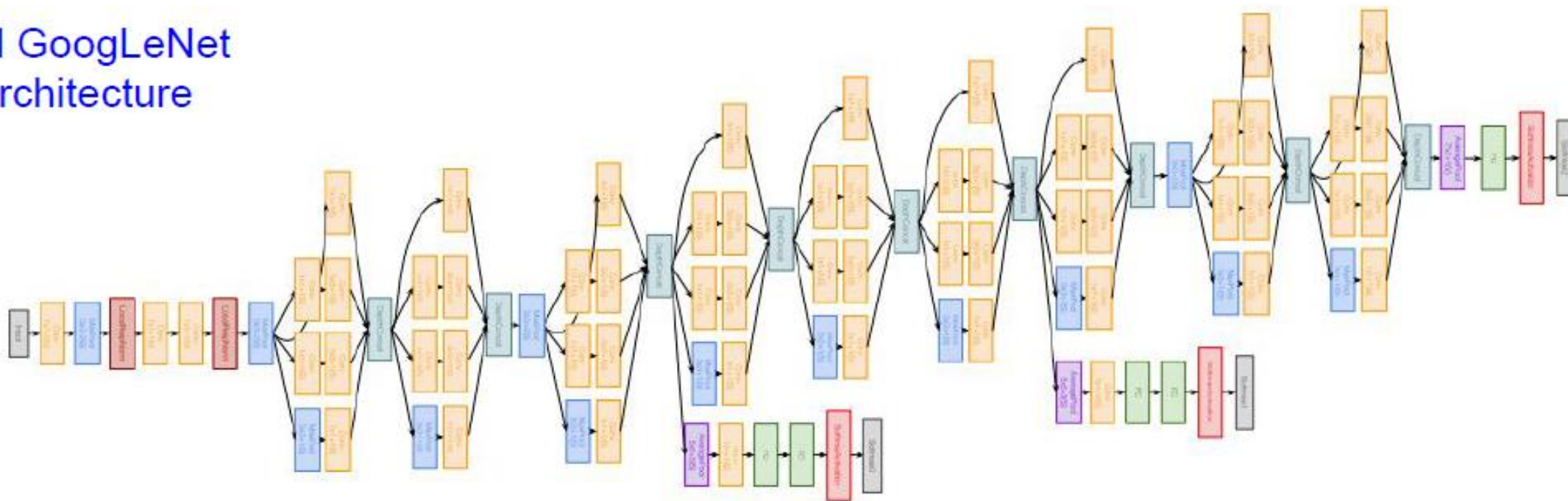


Conv2D(64, (3, 3))

GoogLeNet

[Szegedy et al., 2014]

Full GoogLeNet architecture



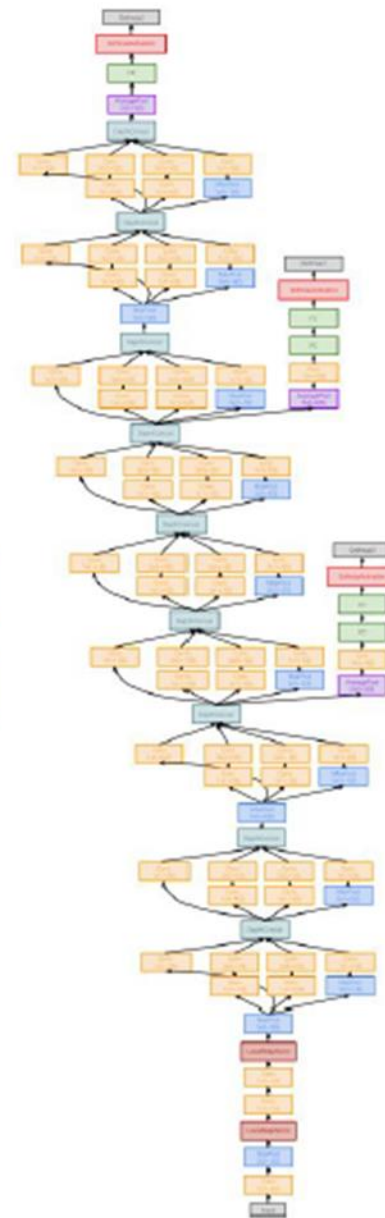
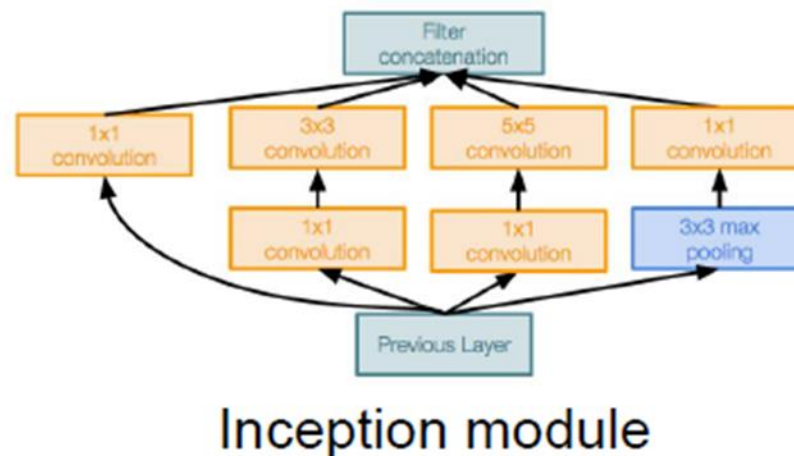
22 total layers with weights

(parallel layers count as 1 layer => 2 layers per Inception module. Don't count auxiliary output layers)

GoogLeNet

Deeper networks, with computational efficiency

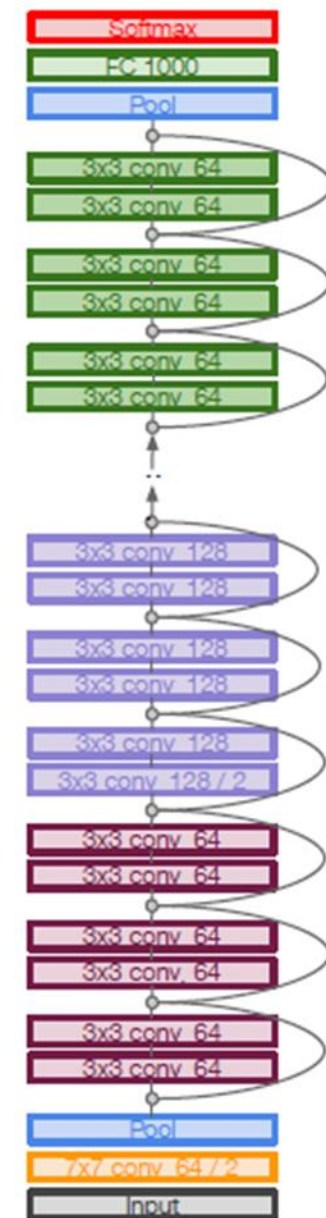
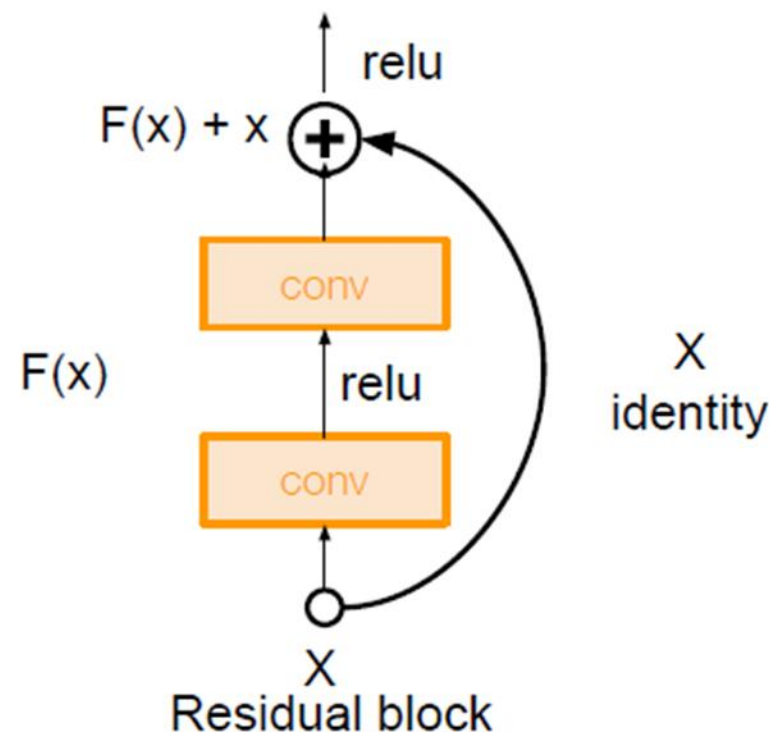
- 22 layers
- Efficient “Inception” module
- Avoids expensive FC layers
- 12x less params than AlexNet
- 27x less params than VGG-16
- ILSVRC’14 classification winner (6.7% top 5 error)



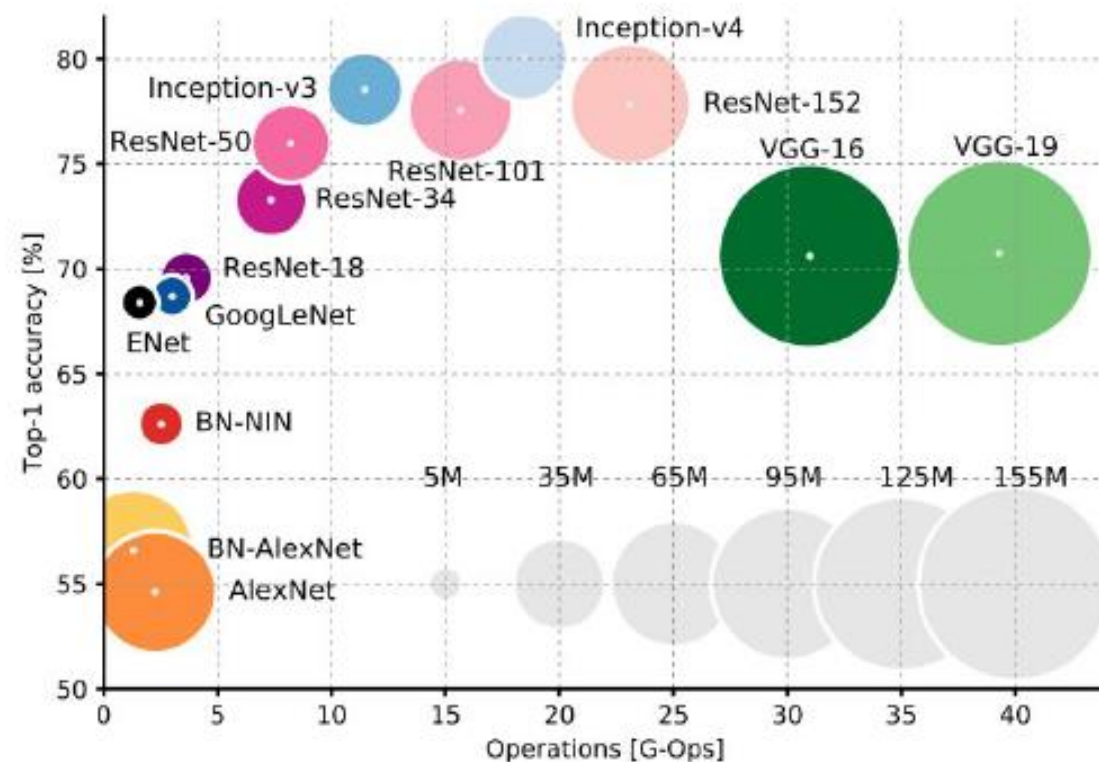
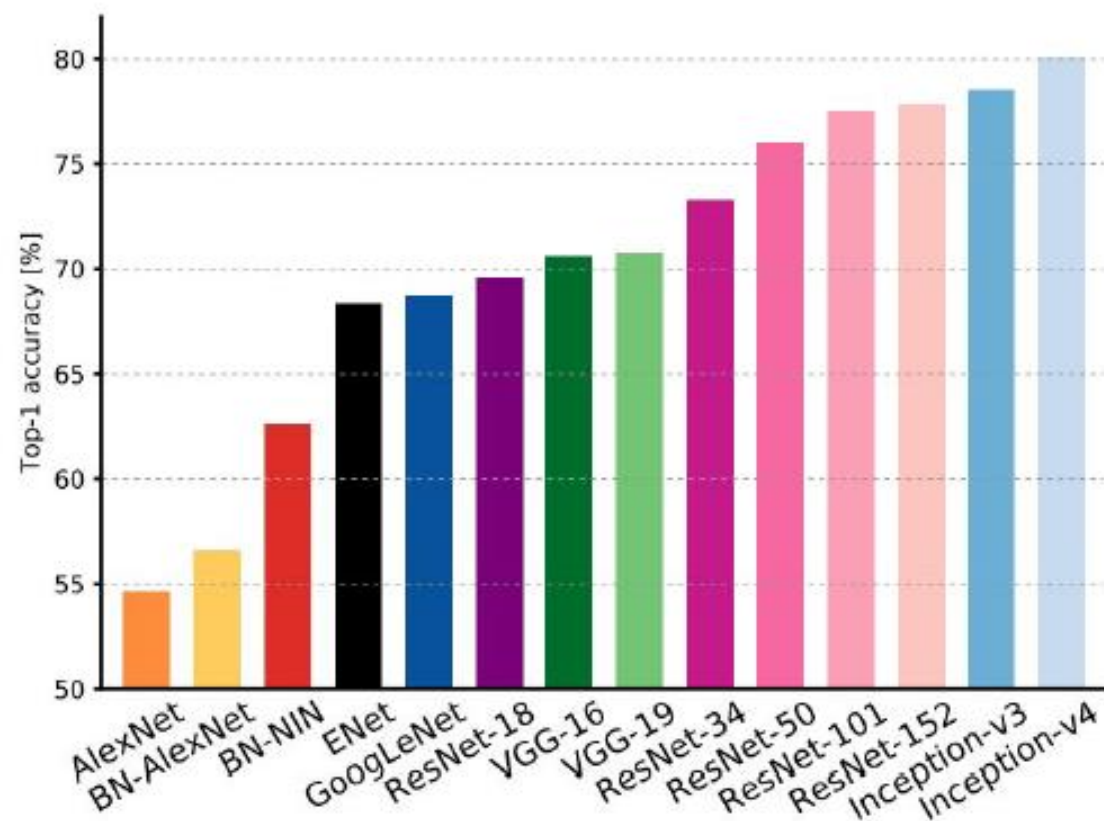
ResNet

Very deep networks using residual connections

- 152-layer model for ImageNet
- ILSVRC'15 classification winner (3.57% top 5 error)
- Swept all classification and detection competitions in ILSVRC'15 and COCO'15!



Comparing complexity...



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

Figures copyright Alfredo Canziani, Adam Paszke, Eugenio Culurciello, 2017. Reproduced with permission.

AlexNet 구현

데이터셋 로드

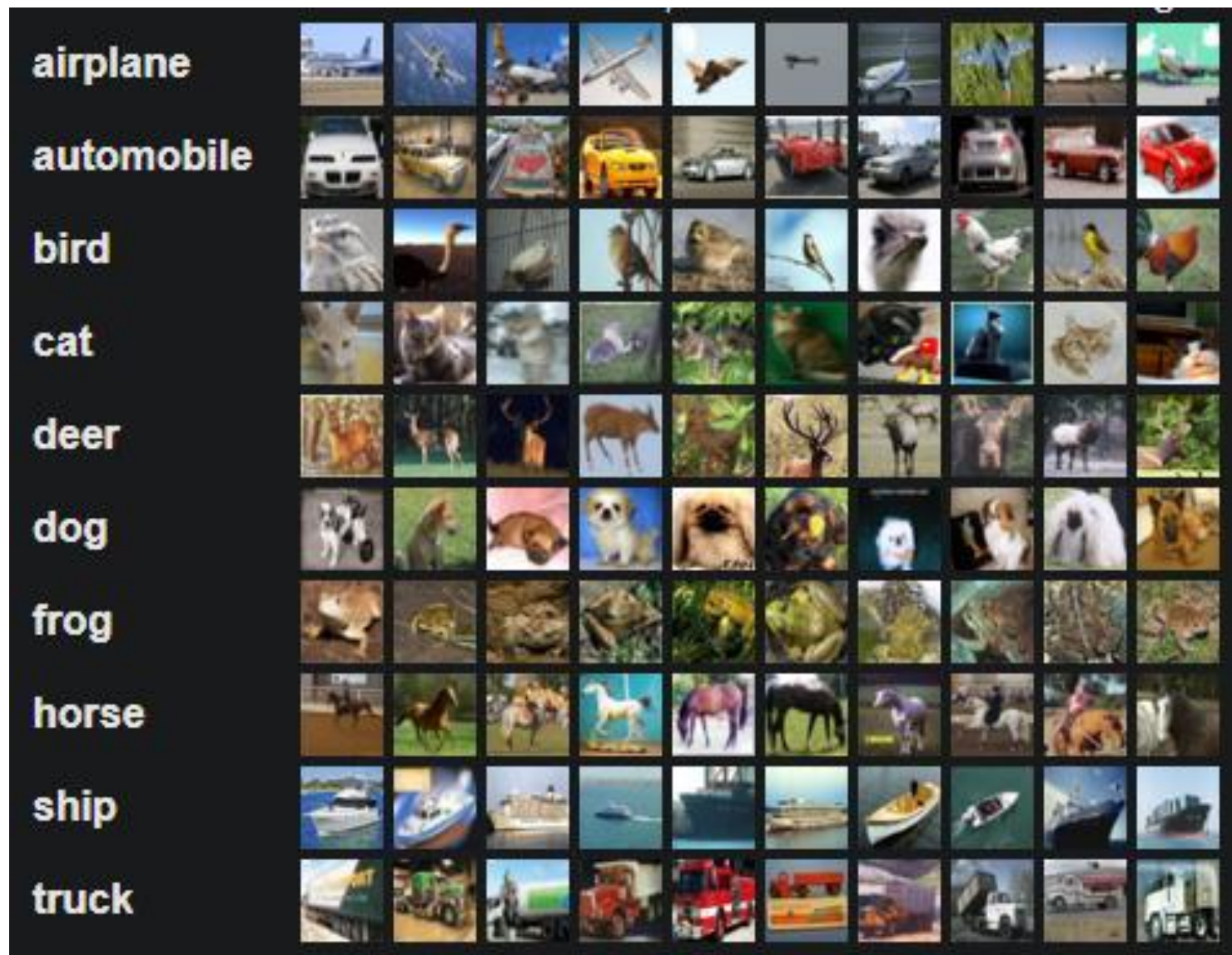
- CIFAR-10 dataset은 32x32픽셀의 60000개 컬러이미지가 포함되어 있습니다.
- 각 이미지는 10개의 클래스로 라벨링이 되어있습니다.
- MNIST와 같이 머신러닝 연구에 가장 널리 사용되는 dataset중 하나입니다.

```
[2] (train_images, train_labels), (test_images, test_labels) = keras.datasets.cifar10.load_data()
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz  
170500096/170498071 [=====] - 2s 0us/step  
170508288/170498071 [=====] - 2s 0us/step
```

```
[3] CLASS_NAMES= ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship', 'truck']
```


AlexNet 구현



라이브러리 импорт

```
[1] import os
import time
import matplotlib.pyplot as plt

import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Activation, Dense, Dropout
from tensorflow.keras.layers import Flatten, Conv2D, MaxPooling2D, BatchNormalization
from tensorflow.keras.optimizers import SGD
from tensorflow.keras.callbacks import TensorBoard
```

데이터셋 로드

- The CIFAR-10 dataset contains 60,000 colour images, each with dimensions 32x32px.
- The content of the images within the dataset is sampled from 10 classes.

```
[2] (train_images, train_labels), (test_images, test_labels) = keras.datasets.cifar10.load_data()
```

```
[3] CLASS_NAMES= ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship', 'truck']
```

데이터셋 분리

```
[4] train_images = train_images[:-5000]
    train_labels = train_labels[:-5000]
    validation_images = train_images[-5000:]
    validation_labels = train_labels[-5000:]
```

```
[5] train_ds = tf.data.Dataset.from_tensor_slices((train_images, train_labels))
    test_ds = tf.data.Dataset.from_tensor_slices((test_images, test_labels))
    validation_ds = tf.data.Dataset.from_tensor_slices((validation_images, validation_labels))
```

이미지 확인

```
[6] plt.figure(figsize=(20,20))
    for i, (image, label) in enumerate(train_ds.take(5)):
        ax = plt.subplot(5,5,i+1)
        plt.imshow(image)
        plt.title(CLASS_NAMES[label.numpy()[0]])
        plt.axis('off')
```

데이터 전처리 함수

```
[7] def process_images(image, label):  
    # Normalize images to have a mean of 0 and standard deviation of 1  
    image = tf.image.per_image_standardization(image)  
    # Resize images from 32x32 to 277x277  
    image = tf.image.resize(image, (277,277))  
    return image, label
```

데이터셋 준비

```
[8] train_ds_size = tf.data.experimental.cardinality(train_ds).numpy()  
validation_ds_size = tf.data.experimental.cardinality(validation_ds).numpy()  
test_ds_size = tf.data.experimental.cardinality(test_ds).numpy()  
  
print("Training dataset size:", train_ds_size)  
print("Validation dataset size:", validation_ds_size)  
print("Test dataset size:", test_ds_size)
```

```
Training dataset size: 45000  
Validation dataset size: 5000  
Test dataset size: 10000
```

```
[9] batch_size = 32

train_ds = (train_ds
            .map(process_images)
            .shuffle(buffer_size=10000)
            .batch(batch_size=batch_size, drop_remainder=True))

validation_ds = (validation_ds
                 .map(process_images)
                 .shuffle(buffer_size=10000)
                 .batch(batch_size=batch_size, drop_remainder=True))

test_ds = (test_ds
           .map(process_images)
           .batch(batch_size=batch_size, drop_remainder=True))
```

```
[10] for d in train_ds:
        print(d)
        break
```



```
[11] model = Sequential()

# 1st Convolutional Layer
model.add(Conv2D(filters=96, input_shape=(227,227,3), kernel_size=(11,11), strides=(4,4), padding='valid'))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='valid'))
model.add(BatchNormalization())

# 2nd Convolutional Layer
model.add(Conv2D(filters=256, kernel_size=(5,5), strides=(1,1), padding='same'))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(3,3), strides=(2,2), padding='valid'))
model.add(BatchNormalization())

# 3rd Convolutional Layer
model.add(Conv2D(filters=384, kernel_size=(3,3), strides=(1,1), padding='same'))
model.add(Activation('relu'))
model.add(BatchNormalization())

# 4th Convolutional Layer
model.add(Conv2D(filters=384, kernel_size=(3,3), strides=(1,1), padding='same'))
model.add(Activation('relu'))
model.add(BatchNormalization())
```

```
# 5th Convolutional Layer
model.add(Conv2D(filters=256, kernel_size=(3,3), strides=(1,1), padding='same'))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(3,3), strides=(2,2), padding='valid'))
model.add(BatchNormalization())

# Passing it to a dense layer
model.add(Flatten())

# 1st Dense Layer
model.add(Dense(4096, input_shape=(227*227*3,)))
model.add(Activation('relu'))
model.add(Dropout(0.4))
model.add(BatchNormalization())

# 2nd Dense Layer
model.add(Dense(4096))
model.add(Activation('relu'))
model.add(Dropout(0.4))
model.add(BatchNormalization())

# output Layer
model.add(Dense(10))

model.add(Activation('softmax'))
```

```
[12] model.summary()
```

```
Model: "sequential"
```

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 55, 55, 96)	34944
activation (Activation)	(None, 55, 55, 96)	0
max_pooling2d (MaxPooling2D)	(None, 27, 27, 96)	0

.....

dense_2 (Dense)	(None, 10)	40970
activation_7 (Activation)	(None, 10)	0

```
Total params: 58,360,586  
Trainable params: 58,341,450  
Non-trainable params: 19,136
```

TensorBoard 로깅 디렉토리 설정

```
[13] tensorboard = TensorBoard('logs/alexnet')
```

모델 컴파일

```
[14] model.compile(loss='sparse_categorical_crossentropy',  
                  optimizer=SGD(learning_rate=0.001),  
                  metrics=['accuracy'])
```

모델 훈련

```
epochs = 30  
  
model.fit(train_ds,  
          epochs=epochs,  
          validation_data=validation_ds,  
          callbacks=[tensorboard])
```

Epoch 29/30

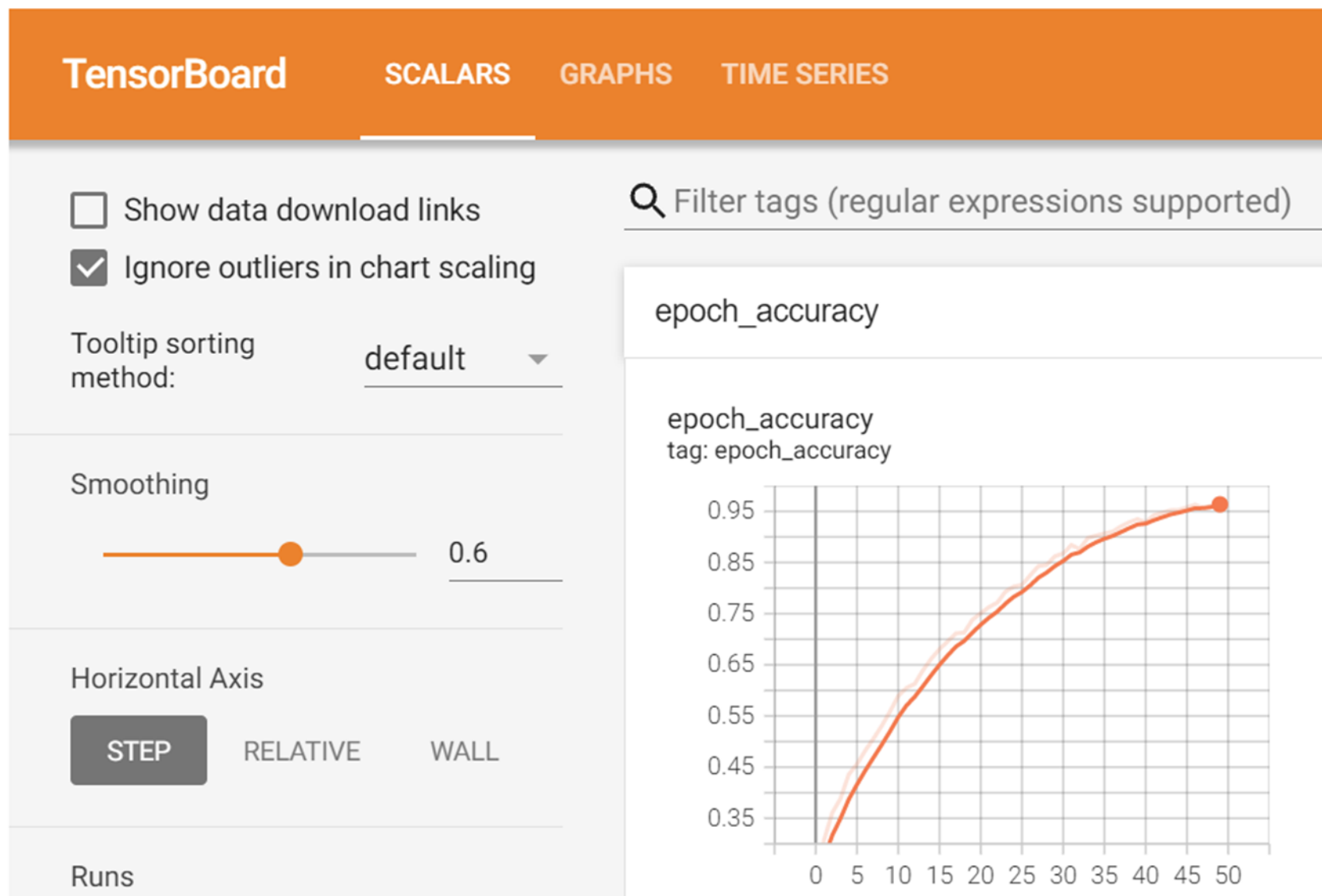
1406/1406 [=====] - 82s 56ms/step - loss: 0.1929 - accuracy: 0.9334 - val_loss: 0.0358 - val_accuracy: 0.9964

Epoch 30/30

1406/1406 [=====] - 81s 56ms/step - loss: 0.1751 - accuracy: 0.9413 - val_loss: 0.0350 - val_accuracy: 0.9954


```
%load_ext tensorboard
```

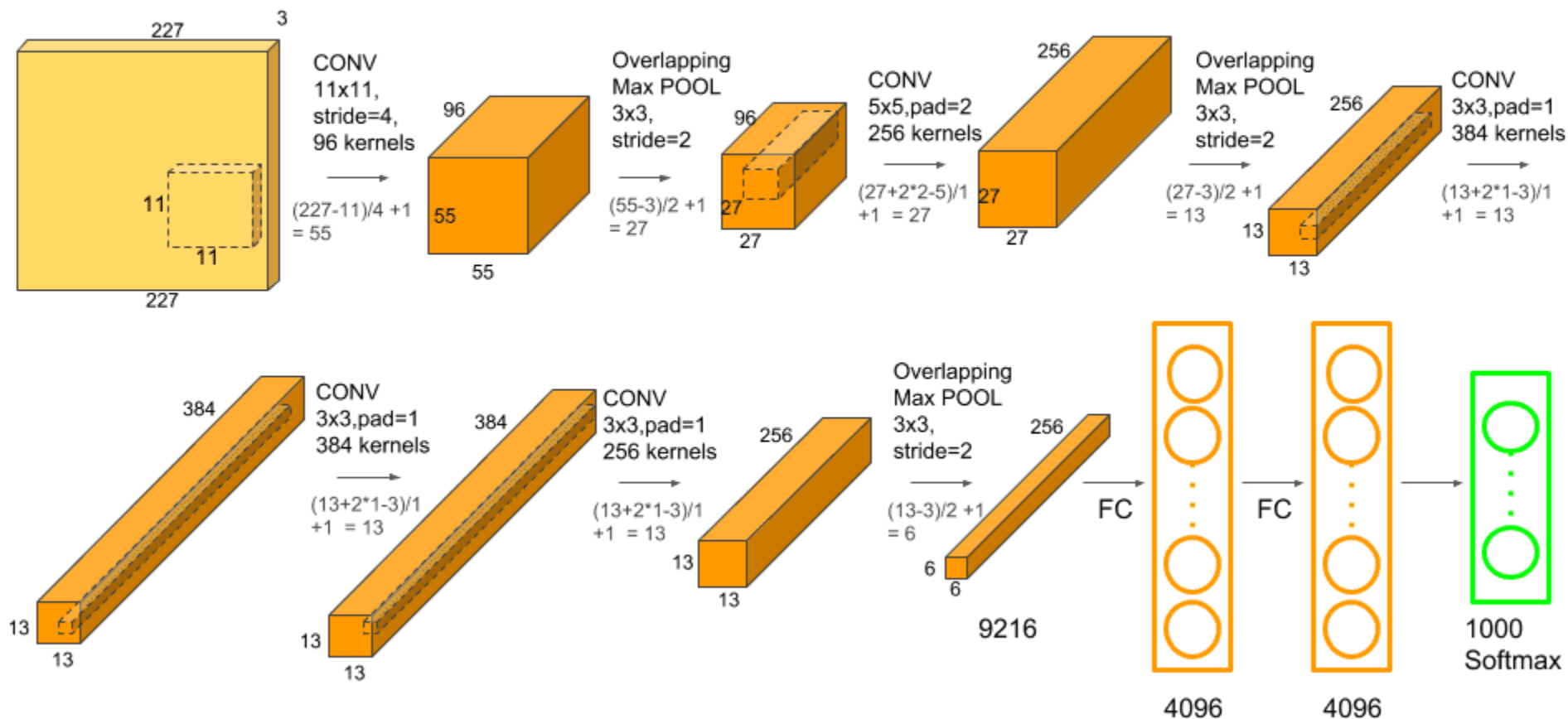
```
%tensorboard --logdir logs/alexnet
```



AlexNet 구현 실습



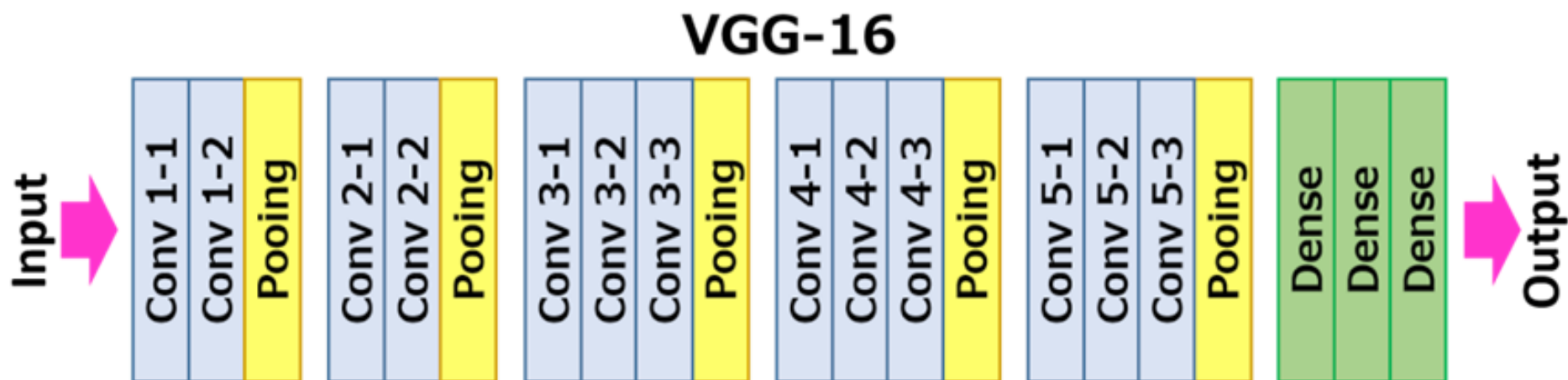
cnn_alexnet.ipynb



VGG-16 구현 실습



cnn_vgg.ipynb



Thank you