AI School 6기 7주차

파이썬 기초 – NumPy, NLTK

CNN 기초2

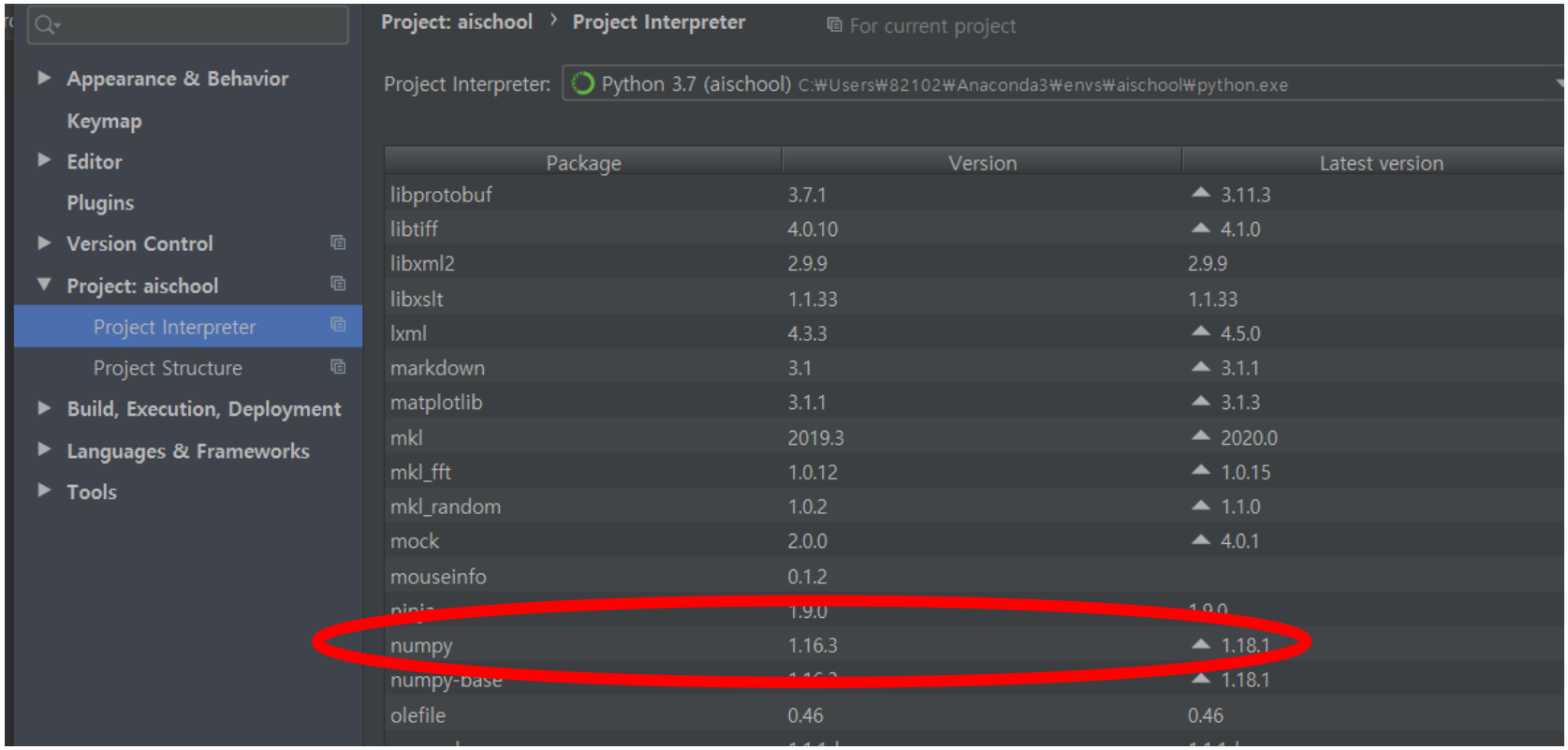
CNN 모델을 활용한 문서&객체 분류

AI School 6기 7주차

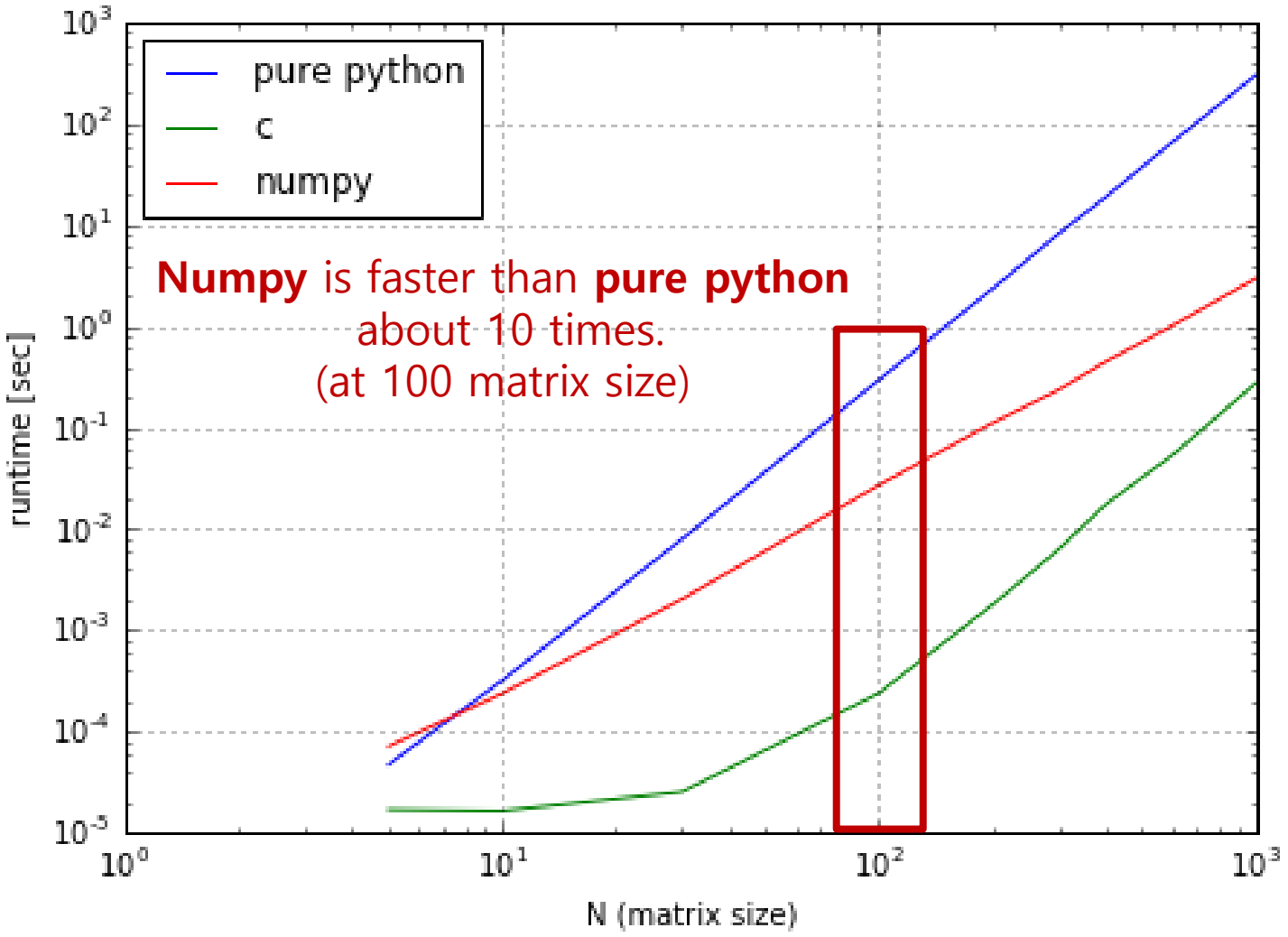
파이썬 기초 – NumPy, NLTK

NumPy

- Numerical Python
  - Extension package for multi-dimensional array.
  - Designed for Scientific computation.
  - Array operations are implemented in C or Fortran.



NumPy


pure python
c
numpy
Numpy is faster than pure python
about 10 times.
(at 100 matrix size)
runtime [sec]
N (matrix size)
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{0}
10^{1}
10^{2}
10^{3}

NumPy

- Creating Matrix

```
import numpy

list_mat = [[1,2,3], [3,6,9], [2,4,6]]
matrix = numpy.array(list_mat)
print(matrix)
print(matrix.shape)
```

1	2	3
3	6	9
2	4	6

```
matrix = numpy.random.rand(3,3)
print(matrix)
```

```
matrix = numpy.zeros((3,3))
print(matrix)
```

NumPy

- Creating Matrix

```
# year hare    lynx    carrot
1900   30e3    4e3     48300
1901   47.2e3  6.1e3   48200
1902   70.2e3  9.8e3   41500
1903   77.4e3  35.2e3  38200
1904   36.3e3  59.4e3  40600
1905   20.6e3  41.7e3  39800
1906   18.1e3  19e3    38600
1907   21.4e3  13e3    42300
1908   22e3    8.3e3   44500
1909   25.4e3  9.1e3   42100
1910   27.1e3  7.4e3   46000
1911   40.3e3  8e3     46800
1912   57e3    12.3e3  43800
1913   76.6e3  19.5e3  40900
1914   52.3e3  45.7e3  39400
1915   19.5e3  51.1e3  39000
1916   11.2e3  29.7e3  36700
1917   7.6e3   15.8e3  41800
1918   14.6e3  9.7e3   43300
1919   16.2e3  10.1e3  41300
1920   24.7e3  8.6e3   47300
```

populations.txt

```
matrix = numpy.loadtxt("populations.txt")
```

```
numpy.savetxt("populations.txt", matrix)
```

```
[[ 1900. 30000.  4000. 48300.]
 [ 1901. 47200.  6100. 48200.]
 [ 1902. 70200.  9800. 41500.]
 [ 1903. 77400. 35200. 38200.]
 [ 1904. 36300. 59400. 40600.]
 [ 1905. 20600. 41700. 39800.]
 [ 1906. 18100. 19000. 38600.]
 [ 1907. 21400. 13000. 42300.]
 [ 1908. 22000.  8300. 44500.]
 [ 1909. 25400.  9100. 42100.]
 [ 1910. 27100.  7400. 46000.]
 [ 1911. 40300.  8000. 46800.]
 [ 1912. 57000. 12300. 43800.]
 [ 1913. 76600. 19500. 40900.]
 [ 1914. 52300. 45700. 39400.]
 [ 1915. 19500. 51100. 39000.]
 [ 1916. 11200. 29700. 36700.]
 [ 1917.  7600. 15800. 41800.]
 [ 1918. 14600.  9700. 43300.]
 [ 1919. 16200. 10100. 41300.]
 [ 1920. 24700.  8600. 47300.]]
```

NumPy

- Matrix slicing

1	2	3
3	6	9
2	4	6

matrix =
[[1,2,3]
[3,6,9]
[2,4,6]]

1	2	3
3	6	9
2	4	6

matrix[1,2]

1	2	3
3	6	9
2	4	6

matrix[1]

1	2	3
3	6	9
2	4	6

matrix[1 : 3]

1	2	3
3	6	9
2	4	6

matrix[: ,1]

NumPy

- Operation
  - All basic operation(+, -, *, /) are performed by each element.

matrix + 3

4	5	6
6	9	12
5	7	9

matrix + matrix

1	2	3
4	5	6
7	8	9

+

1	0	0
0	1	0
0	0	1

=

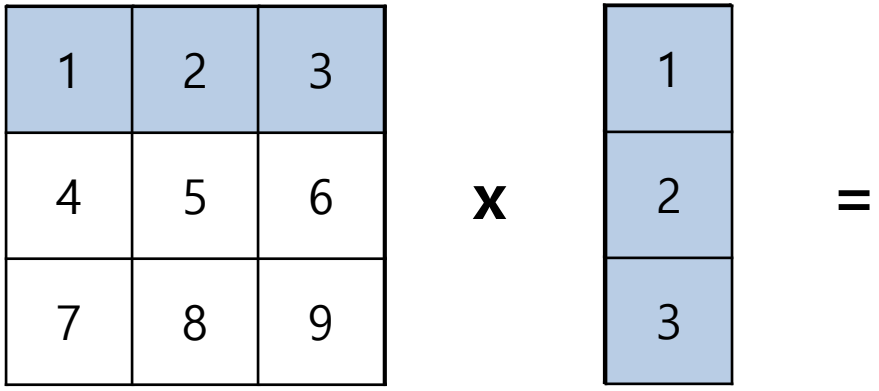
2	2	3
4	6	6
7	8	10

NumPy

- Operation
  - Array operation.
  - More information (https://docs.scipy.org/doc/numpy/reference/routines.html)

matrix * vector

1	2	3
8	10	12
21	24	27



matrix　　vector

matrix.dot(vector)

14
32
50

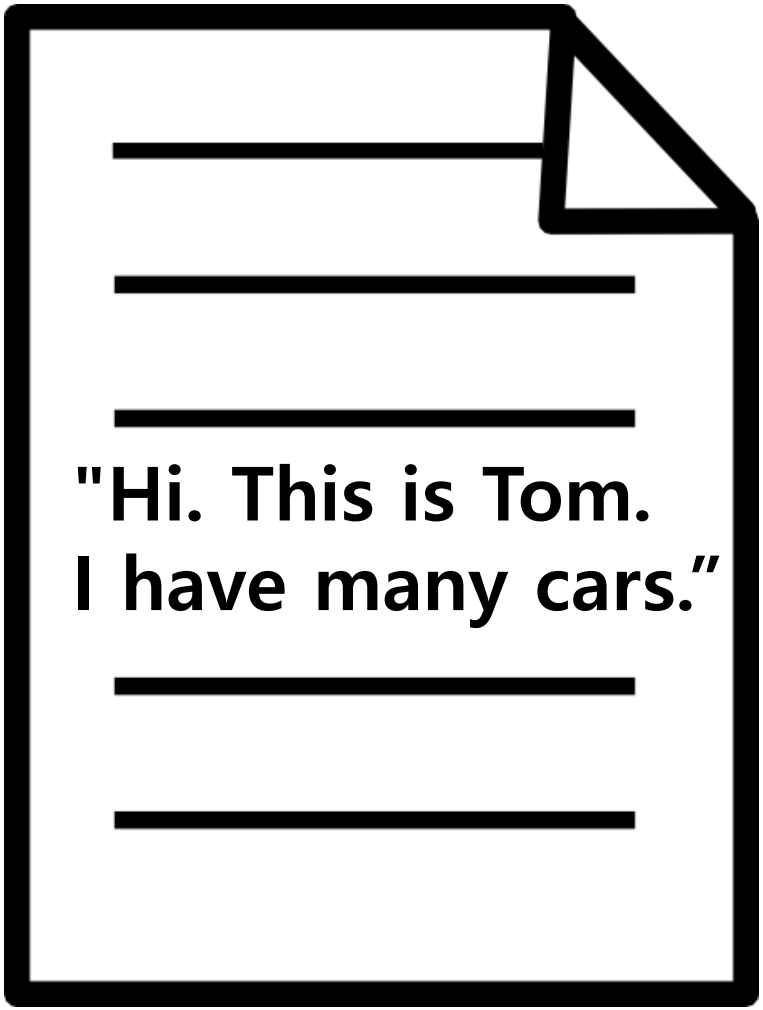
NLTK

- **Natural language processing** (**NLP**) is a field of computer science, artificial intelligence and computational linguistics concerned with **the interactions between computers and human (natural) languages**, and, in particular, concerned with programming computers to fruitfully process large natural language corpora. (wikipedia)

- Data pre-processing (데이터 전처리)
  1. Tokenize
  2. Stemming
  3. Stopwords

NLTK

- Tokenize



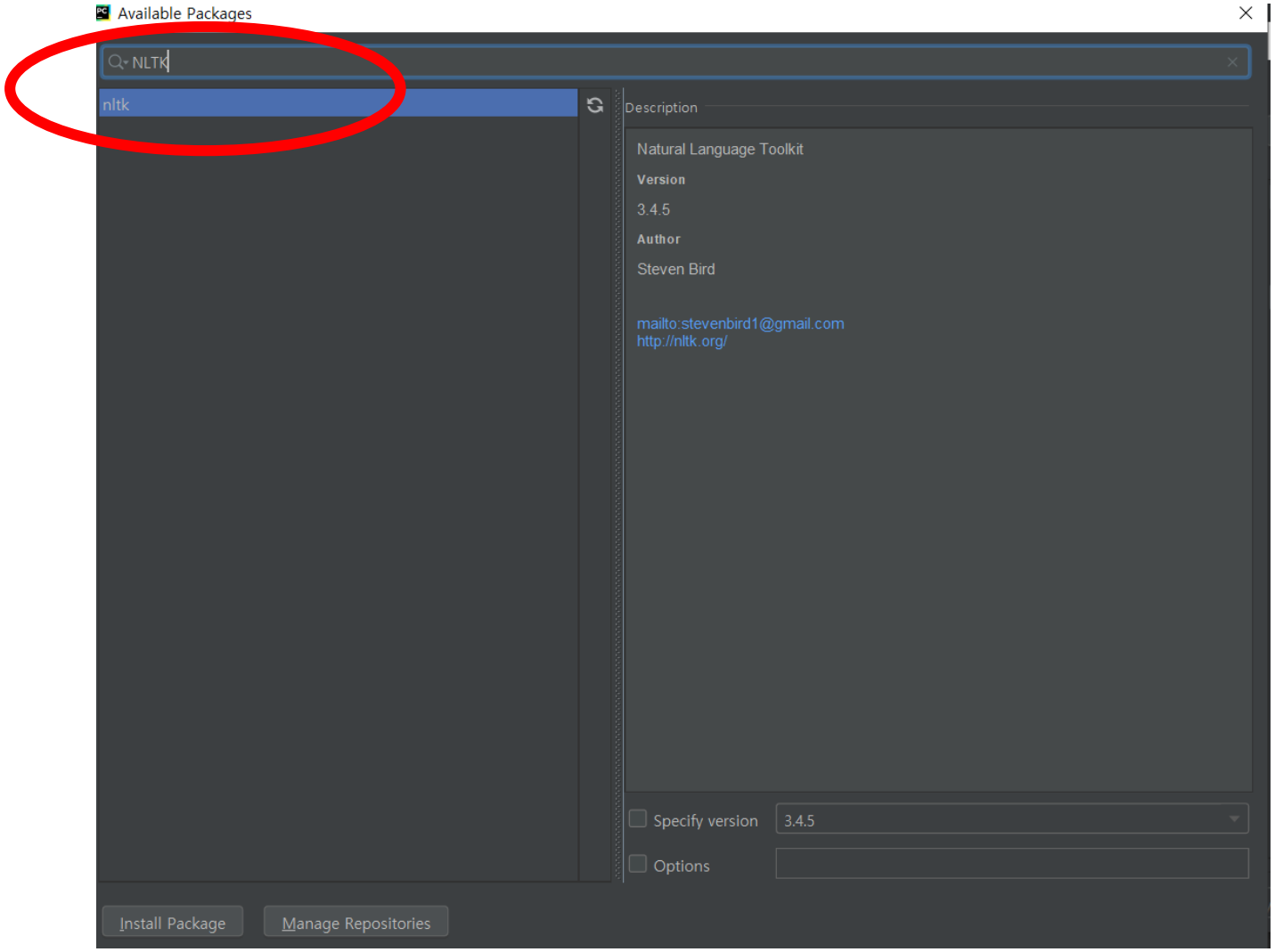
token: 어휘 분석(lexical analysis)의 단위

tokenize

‘hi’, ‘tom’, ‘mani’, ‘car’

NLTK

- NLTK 설치

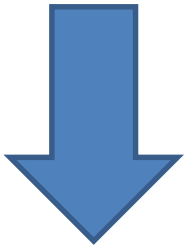

Available Packages
NLTK
nltk
Description
Natural Language Toolkit
Version
3.4.5
Author
Steven Bird
mailto:stevenbird1@gmail.com
http://nltk.org/
Specify version
3.4.5
Options
Install Package
Manage Repositories

NLTK

- Tokenizer

```
import nltk

# nltk.download()
sentence = "Hi . This is Tom . I have many cars ."
sentence = sentence.lower()
tokens = nltk.word_tokenize(sentence)
print(tokens)
text = nltk.Text(tokens)
print(text)
print(len(text.tokens))
print(len(set(text.tokens)))
```

Hi. This is Tom. I have many cars.



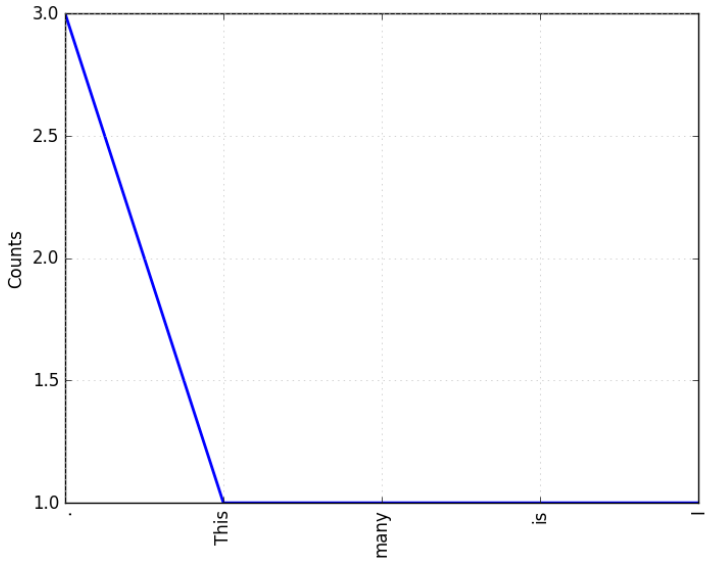
tokenize

['hi', '.', 'this', 'is', 'tom', '.', 'i', 'have', 'many', 'cars', '.']

NLTK

- Tokenizer

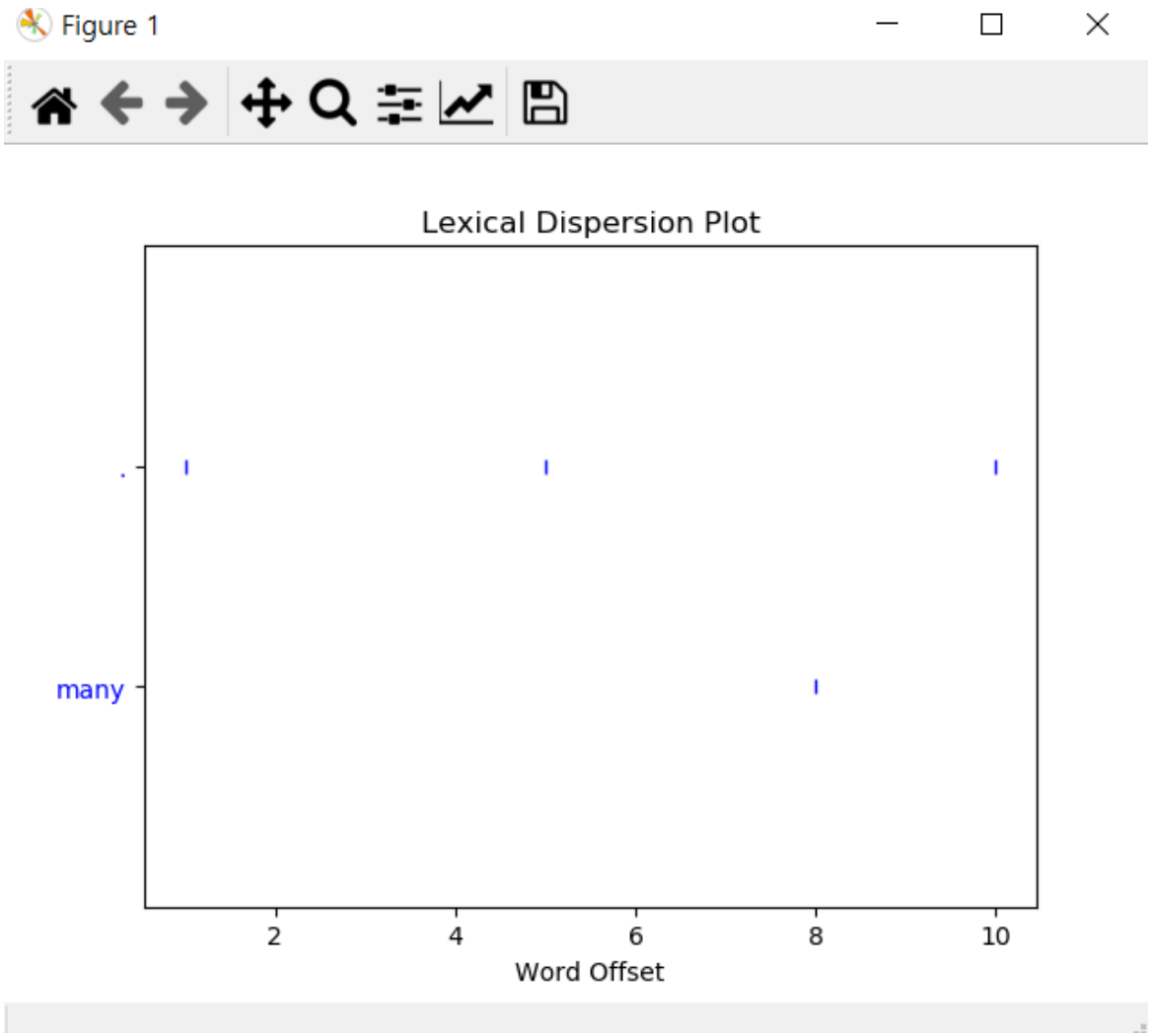
```
import nltk

# nltk.download()
sentence = "Hi . This is Tom . I have many cars ."
sentence = sentence.lower()
tokens = nltk.word_tokenize(sentence)
print(tokens)
text = nltk.Text(tokens)
print(text)
print(len(text.tokens))
print(len(set(text.tokens)))

for token in text.vocab():
    print(token, text.vocab()[token])

text.plot(5)
```



NLTK

- Tokenizer

```
text.count('.')
text.count('many')
text.dispersion_plot(['.', 'many'])
```



NLTK

- Stopwords

```
import nltk
from nltk.corpus import stopwords
sentence = "Hi . This is Tom . I have many cars ."
sentence = sentence.lower()
tokens = nltk.word_tokenize(sentence)
stop = set(stopwords.words('english'))
tokens = [t for t in tokens if t not in stop]
print(tokens)
print('this' in stop)
```

Word	Frequency
the	1061396
of	593677
and	416629
in	372201
a	325873
…	…

Top term frequency

['hi', '.', 'this', 'is', 'tom', '.', 'i', 'have', 'many', 'cars', '.']

remove stopwords

['hi', '.', 'tom', '.', 'many', 'cars', '.']

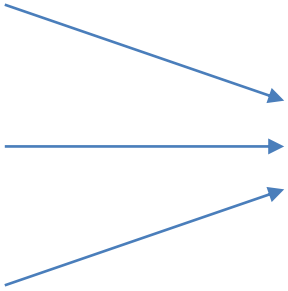
NLTK

- Stemming

closing

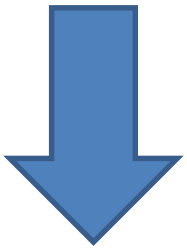
closed

closely



Clos-

['hi', '.', 'tom', '.', 'many', 'cars', '.']



stemming

['hi', '.', 'tom', '.', 'mani', 'car', '.']

NLTK

- Stemming

```
from nltk.corpus import stopwords
from nltk.stem.porter import PorterStemmer

sentence = "Hi . This is Tom . I have many cars ."
sentence = sentence.lower()
tokens = nltk.word_tokenize(sentence)
stop = set(stopwords.words('english'))
tokens = [t for t in tokens if t not in stop]
porter_stemmer = PorterStemmer()
tokens = [porter_stemmer.stem(token) for token in tokens]
print(tokens)
```

```
'hi'
'.'
'tom'
'.'
'mani'
'car'
'.'
```

Document similarity

- One-hot encoding (단어)

vocabulary

[orange, apple, car, fruit, vehicle]

	orange	apple	car	fruit	vehicle
orange	**1**	0	0	0	0
apple	0	**1**	0	0	0
car	0	0	**1**	0	0
fruit	0	0	0	**1**	0
vehicle	0	0	0	0	**1**

orange = [1, 0, 0, 0, 0], apple = [0, 1, 0, 0, 0], car = [0, 0, 1, 0, 0], fruit = [0, 0, 0, 1, 0], vehicle = [0, 0, 0, 0, 1]

Document similarity

- One-hot encoding (문장)

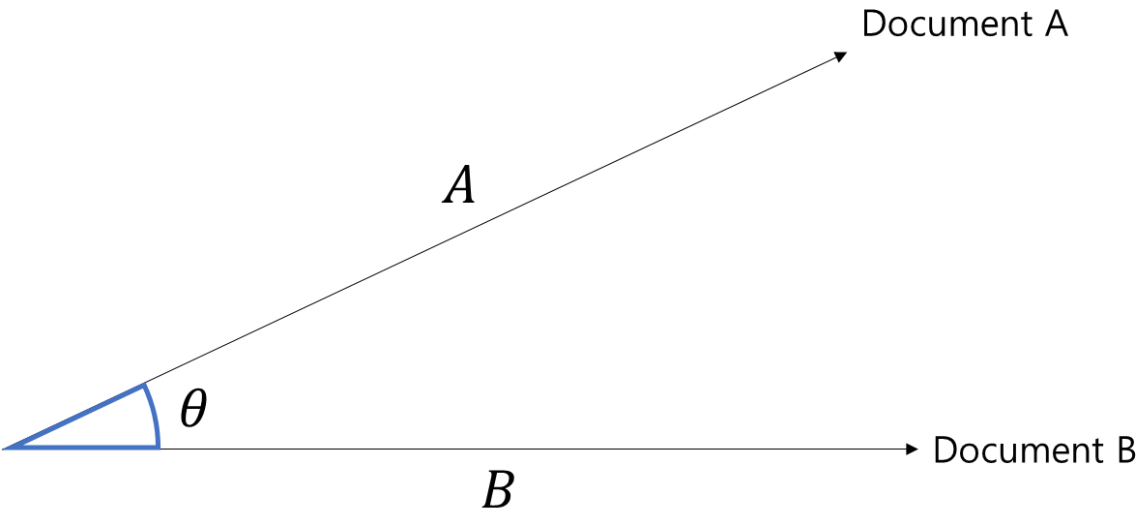
orange = [1, 0, 0, 0, 0], apple = [0, 1, 0, 0, 0], car = [0, 0, 1, 0, 0], fruit = [0, 0, 0, 1, 0], vehicle = [0, 0, 0, 0, 1]

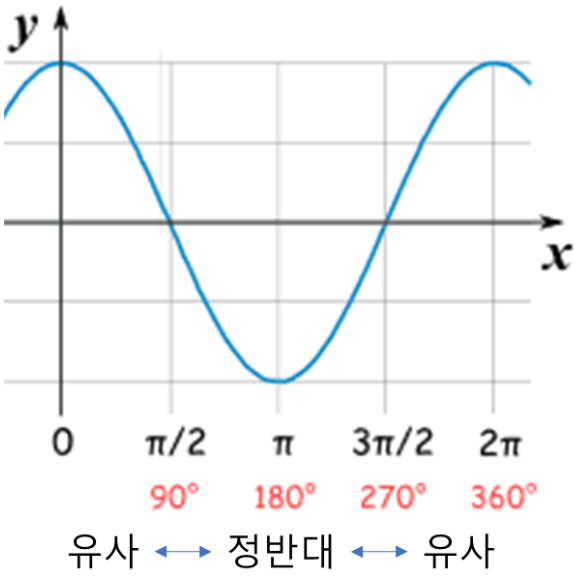
		orange	apple	car	fruit	vehicle
Orange is fruit	Doc1	1	0	0	1	0
Apple is fruit	Doc2	0	1	0	1	0
Car is vehicle	Doc3	0	0	1	0	1
Orange and apple are fruits	Doc4	1	1	0	0	0

Doc4 = orange + apple

Document similarity

- Cosine similarity





$$A \cdot B = |A||B|cos\theta$$

Cosine similarity는 클수록 **유사도**가 높음을 의미

Document similarity

- Cosine similarity

$$A \cdot B = |A||B|cos\theta \longrightarrow cos\theta = \frac{A \cdot B}{|A||B|}$$

$$\text{cosine similarity} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}}$$

```
def get_sim(A, B):
        s1 = np.dot(A, B)
        s2 = np.sqrt(np.sum(A*A))
        s3 = np.sqrt(np.sum(B*B))
        return s1 / (s2*s3)
```

Document similarity

- Cosine similarity

$$\text{cosine similarity} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}}$$

		orange	apple	car	fruit	vehicle
Orange is fruit	Doc1	1	0	0	1	0
Apple is fruit	Doc2	0	1	0	1	0
Car is vehicle	Doc3	0	0	1	0	1
Orange and apple are fruits	Doc4	1	1	0	0	0

$$\text{Sim(Doc1, Doc2)} = \frac{1}{\sqrt{2}\sqrt{2}} = \frac{1}{2} = 0.5$$

$$\text{Sim(Doc1, Doc3)} = \frac{0}{\sqrt{2}\sqrt{2}} = \frac{0}{2} = 0$$

$$\text{Sim(Doc1, Doc4)} = \frac{1}{\sqrt{2}\sqrt{2}} = \frac{1}{2} = 0.5$$

Homework

주어진 3문장 간에 유사도를 구하세요.

1. pre-processing (tokenize, stopwords 제거, stemming)
2. Cosine similarity 함수 구현
3. Doc-word matrix 만들기 (단어 사전 구축, numpy로 벡터화)
4. Similarity 구하기 (doc1&doc2:0, doc1&doc3:0, doc2&doc3: x)

doc1

Rafael Nadal Parera is tennis player.

['rafael', 'nadal', 'parera', 'tenni', 'player']

doc2

Donald Trump is president.

['donald', 'trump', 'presid']

doc3

Donald Trump has yellow hair.

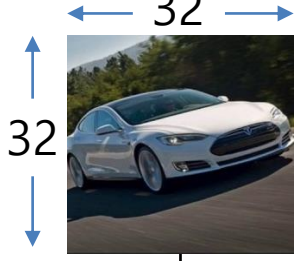
['donald', 'trump', 'yellow', 'hair']

	rafael	nadal	parera	tenni	player	donald	trump	presid	yellow	hair
doc1	1	1	1	1	1	0	0	0	0	0
doc2	0	0	0	0	0	1	1	1	0	0
doc3	0	0	0	0	0	1	1	0	1	1

AI School 6기 7주차

CNN 모델을 활용한 객체 분류

ResNet for CIFAR-10



1
# of filter: 16

3x3 conv, 16

2n
# of filter: 16

3x3 conv, 16
3x3 conv, 16
3x3 conv, 16
3x3 conv, 16
3x3 conv, 16
3x3 conv, 16

2n
# of filter: 32

3x3 conv, 32, /2
3x3 conv, 32
3x3 conv, 32
3x3 conv, 32
3x3 conv, 32
3x3 conv, 32

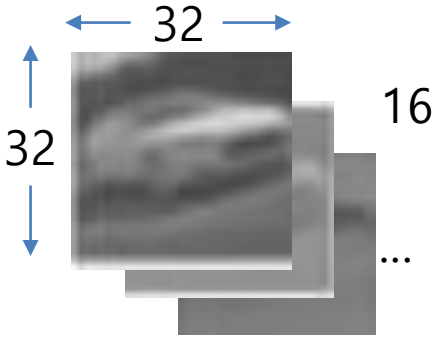
2n
# of filter: 64

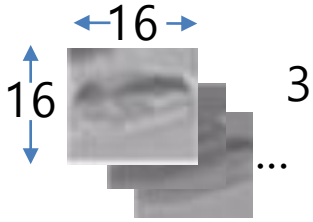
3x3 conv, 64, /2
3x3 conv, 64
3x3 conv, 64
3x3 conv, 64
3x3 conv, 64
3x3 conv, 64

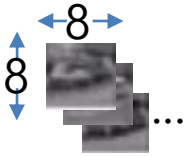
avg pool

1

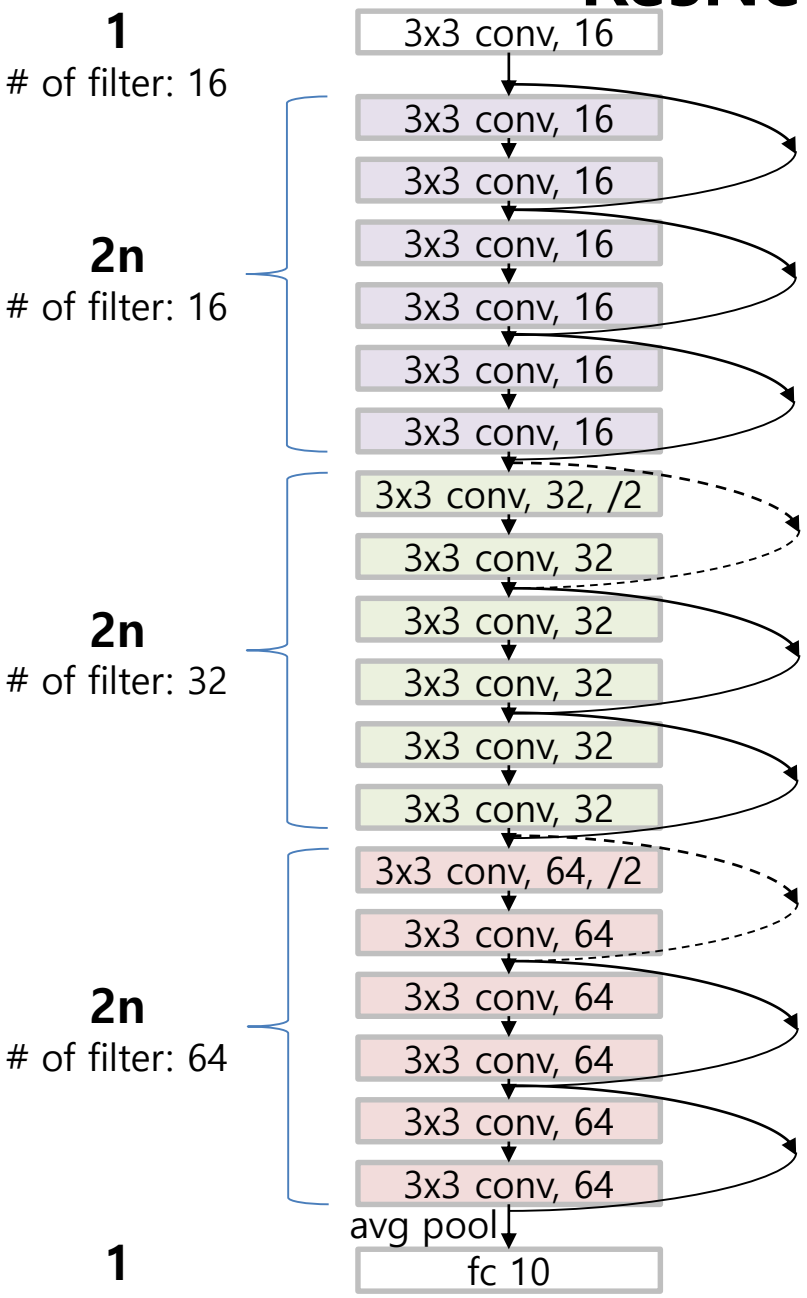
fc 10







ResNet for CIFAR-10



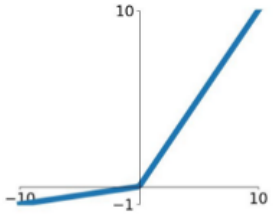
	method			error (%)
n=3	ResNet	20	0.27M	8.75
n=5	ResNet	32	0.46M	7.51
n=7	ResNet	44	0.66M	7.17
n=9	ResNet	56	0.85M	6.97
n=18	ResNet	110	1.7M	**6.43** (6.61±0.16)
n=200	ResNet	1202	19.4M	7.93

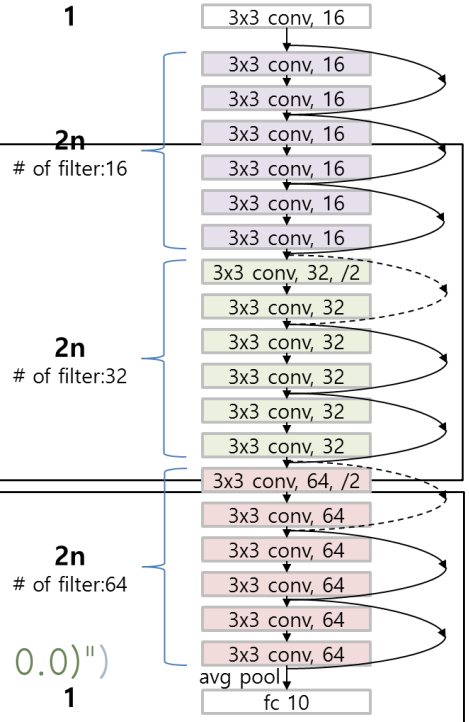
(6n +2)

Hyperparameters

- resnet_train.py

```
import tensorflow as tf
import os
import time
import datetime
import CIFAR.data_helpers as dh
from CIFAR.resnet import ResNet
from tensorflow.keras.datasets.cifar10 import load_data
```





0보다 작을 때 기울기

```
# Model Hyperparameters
tf.flags.DEFINE_float("lr", 0.1, "learning rate (default=0.1)")
tf.flags.DEFINE_float("lr_decay", 0.1, "learning rate decay rate(default=0.1)")
tf.flags.DEFINE_float("l2_reg_lambda", 0.0001, "L2 regularization lambda (default: 0.0)")
tf.flags.DEFINE_float("relu_leakiness", 0.1, "relu leakiness (default: 0.1)")
tf.flags.DEFINE_integer("num_residual_units", 3, "The number of residual_units (default: 5)")
tf.flags.DEFINE_integer("num_classes", 10, "The number of classes (default: 10)")
# Training parameters
tf.flags.DEFINE_integer("batch_size", 128, "Batch Size (default: 64)")
tf.flags.DEFINE_integer("num_epochs", 100, "Number of training epochs (default: 200)")
tf.flags.DEFINE_integer("evaluate_every", 100, "Evaluate model on dev set after this many steps (default:
100)")
tf.flags.DEFINE_integer("checkpoint_every", 100, "Save model after this many steps (default: 100)")
tf.flags.DEFINE_integer("num_checkpoints", 3, "Number of checkpoints to store (default: 5)")
# Misc Parameters
tf.flags.DEFINE_boolean("allow_soft_placement", True, "Allow device soft device placement")
tf.flags.DEFINE_boolean("log_device_placement", False, "Log placement of ops on devices")
FLAGS = tf.flags.FLAGS
```

6n +2

Unit 개수, 즉 n의 크기

Data loading & preprocessing

- resnet_train.py

```
(x_train_val, y_train_val), (x_test, y_test) = load_data()
x_train, y_train, x_test, y_test, x_val, y_val = dh.shuffle_data(x_train_val, y_train_val, x_test, y_test)
```

- data_helpers.py

```
import numpy as np
import random

def shuffle_data(x_train_val, y_train_val, x_test, y_test):
    shuffle_indices = np.random.permutation(np.arange(len(y_train_val)))
    shuffled_x = np.asarray(x_train_val[shuffle_indices])
    shuffled_y = y_train_val[shuffle_indices]
    val_sample_index = -1 * int(0.1 * float(len(y_train_val)))  # -5000
    x_train, x_val = shuffled_x[:val_sample_index], shuffled_x[val_sample_index:]
    y_train, y_val = shuffled_y[:val_sample_index], shuffled_y[val_sample_index:]
    x_test = np.asarray(x_test)
    y_train_one_hot = np.eye(10)[y_train]  # [0, 9] -> [[0, 0, 0, 0, 0, 0, 0, 0, 1], [0, 0, 0, 0, 0, 0, 0, 1, 0]
    y_train_one_hot = np.squeeze(y_train_one_hot, axis=1)  # (45000, 10)
    y_test_one_hot = np.eye(10)[y_test]
    y_test_one_hot = np.squeeze(y_test_one_hot, axis=1)
    y_val_one_hot = np.eye(10)[y_val]
    y_val_one_hot = np.squeeze(y_val_one_hot, axis=1)
    return x_train, y_train_one_hot, x_test, y_test_one_hot, x_val, y_val_one_hot
```

index	label
0	airplane (0)
1	automobile (1)
2	bird (2)
3	cat (3)
4	deer (4)
5	dog (5)
6	frog (6)
7	horse (7)
8	ship (8)
9	truck (9)
...	...
...	...

original label data

label	index									
	0	1	2	3	4	5	6	7	8	9
airplane	1	0	0	0	0	0	0	0	0	0
automobile	0	1	0	0	0	0	0	0	0	0
bird	0	0	1	0	0	0	0	0	0	0
cat	0	0	0	1	0	0	0	0	0	0
deer	0	0	0	0	1	0	0	0	0	0
dog	0	0	0	0	0	1	0	0	0	0
frog	0	0	0	0	0	0	1	0	0	0
horse	0	0	0	0	0	0	0	1	0	0
ship	0	0	0	0	0	0	0	0	1	0
truck	0	0	0	0	0	0	0	0	0	1

one-hot-encoded label data

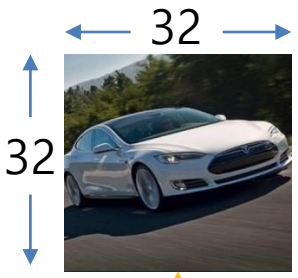
ResNet class & input

- resnet_train.py

```
with tf.Graph().as_default():
    session_conf = tf.ConfigProto(
      allow_soft_placement=FLAGS.allow_soft_placement,
      log_device_placement=FLAGS.log_device_placement)
    sess = tf.Session(config=session_conf)
    with sess.as_default():
        resnet = ResNet(FLAGS)
```

- resnet.py

```
import tensorflow as tf
import numpy as np
from tensorflow.python.training import moving_averages

class ResNet:
    def __init__(self, config):

        self._num_residual_units = config.num_residual_units
        self._batch_size = config.batch_size
        self._relu_leakiness = config.relu_leakiness
        self._num_classes = config.num_classes
        self._l2_reg_lambda = config.l2_reg_lambda

        self.X = tf.placeholder(tf.float32, [None, 32, 32, 3], name="X")
        self.Y = tf.placeholder(tf.float32, [None, self._num_classes], name="Y")
        self.extra_train_ops = []
```



label	index									
	0	1	2	3	4	5	6	7	8	9
airplane	1	0	0	0	0	0	0	0	0	0
automobile	0	1	0	0	0	0	0	0	0	0
bird	0	0	1	0	0	0	0	0	0	0
cat	0	0	0	1	0	0	0	0	0	0
deer	0	0	0	0	1	0	0	0	0	0
dog	0	0	0	0	0	1	0	0	0	0
frog	0	0	0	0	0	0	1	0	0	0
horse	0	0	0	0	0	0	0	1	0	0
ship	0	0	0	0	0	0	0	0	1	0
truck	0	0	0	0	0	0	0	0	0	1

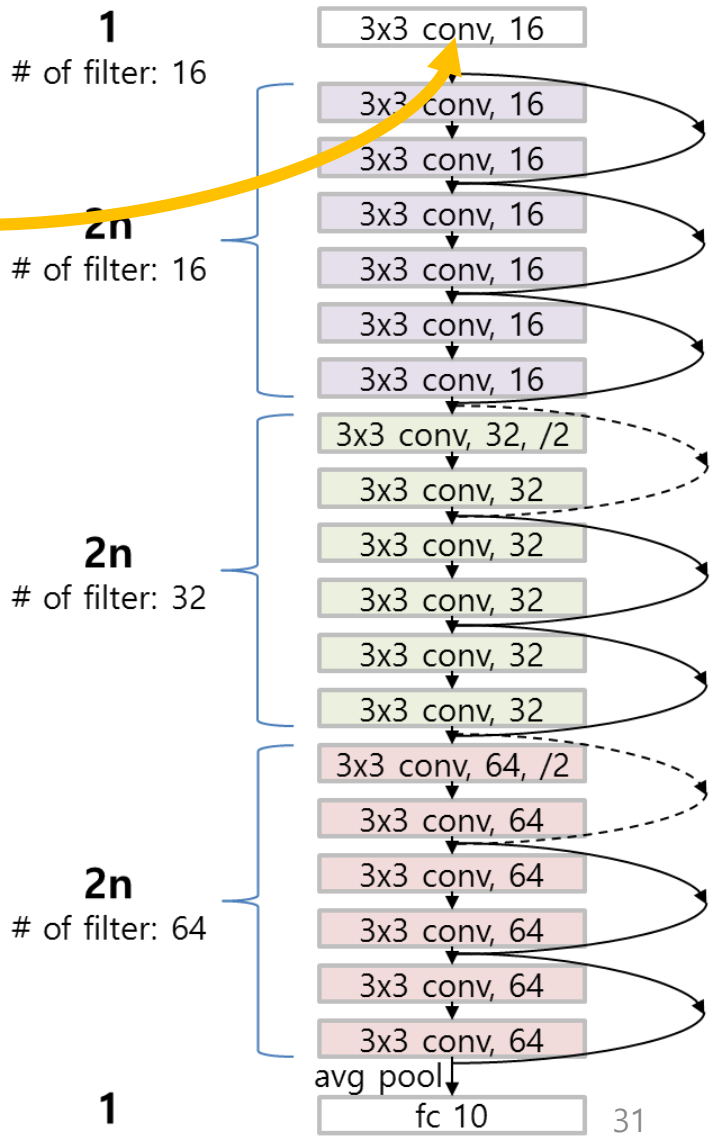
Initial convolutional layer

- resnet.py

```
filters = [16, 16, 32, 64]
activate_before_residual = [True, False, False]

with tf.variable_scope('init'):
  x = self._conv('init_conv', self.X, 3, 3, filters[0], strides=[1,
1, 1, 1])
```

층별 filter 개수 (output channel)

최초 convolutional layer

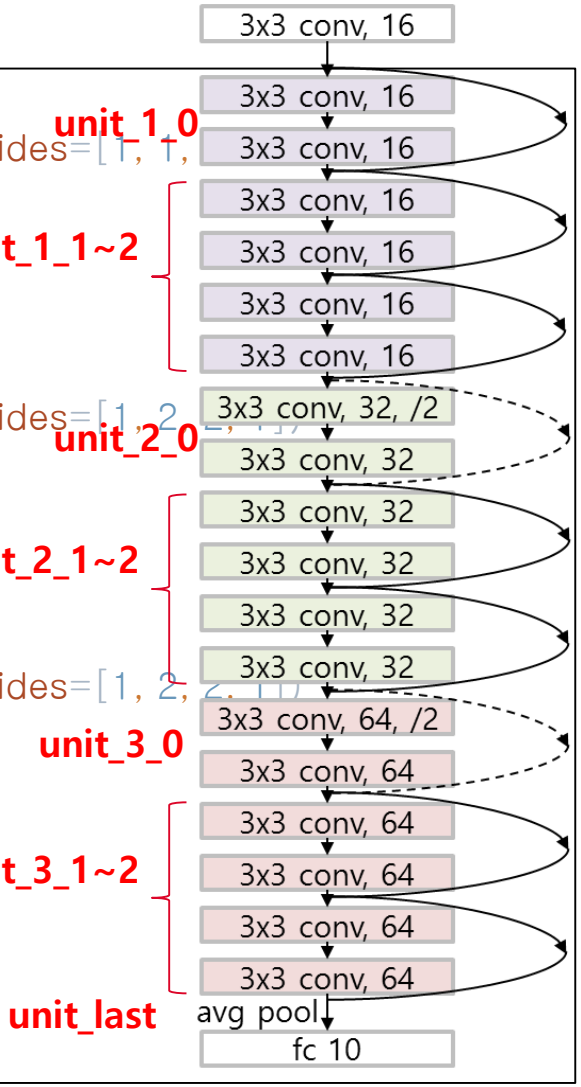


Residual units

- resnet.py

n = 3일 때

```
with tf.variable_scope('unit_1_0'):
  x = self._residual(x, filters[0], filters[1], activate_before_residual[0], strides=[1, 1,
for i in range(1, self._num_residual_units):
  with tf.variable_scope('unit_1_%d' % i):
    x = self._residual(x, filters[1], filters[1], strides=[1, 1, 1, 1])

with tf.variable_scope('unit_2_0'):
  x = self._residual(x, filters[1], filters[2], activate_before_residual[1], strides=[1, 2,
for i in range(1, self._num_residual_units):
  with tf.variable_scope('unit_2_%d' % i):
    x = self._residual(x, filters[2], filters[2], strides=[1, 1, 1, 1])

with tf.variable_scope('unit_3_0'):
  x = self._residual(x, filters[2], filters[3], activate_before_residual[2], strides=[1, 2, 2,
for i in range(1, self._num_residual_units):
  with tf.variable_scope('unit_3_%d' % i):
    x = self._residual(x, filters[3], filters[3], strides=[1, 1, 1, 1])

with tf.variable_scope('unit_last'):
  x = self._batch_norm('final_bn', x)
  x = self._relu(x, self._relu_leakiness)
  x = self._global_avg_pool(x)
```

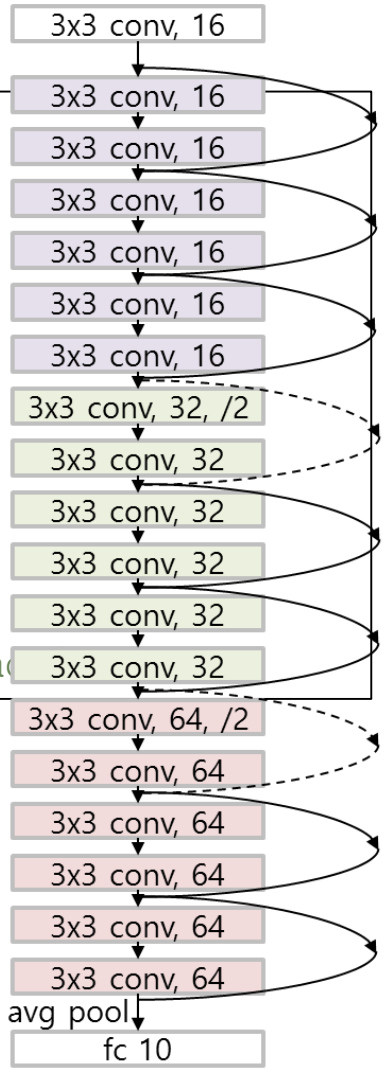


Fully connected layer, weight decay

- resnet.py

```
with tf.variable_scope('logit'):
  logits = self._fully_connected(x, self._num_classes)
  self.predictions = tf.nn.softmax(logits)
  self.predictions = tf.argmax(self.predictions, 1, name="predictions")

with tf.variable_scope('loss'):
  xent = tf.nn.softmax_cross_entropy_with_logits(logits=logits, labels=self.Y)
  self.loss = tf.reduce_mean(xent, name='xent')
  self.loss += self._decay()

with tf.name_scope("accuracy"):
    correct_predictions = tf.equal(self.predictions, tf.argmax(self.Y, 1))
    self.accuracy = tf.reduce_mean(tf.cast(correct_predictions, "float"), name="accura
```

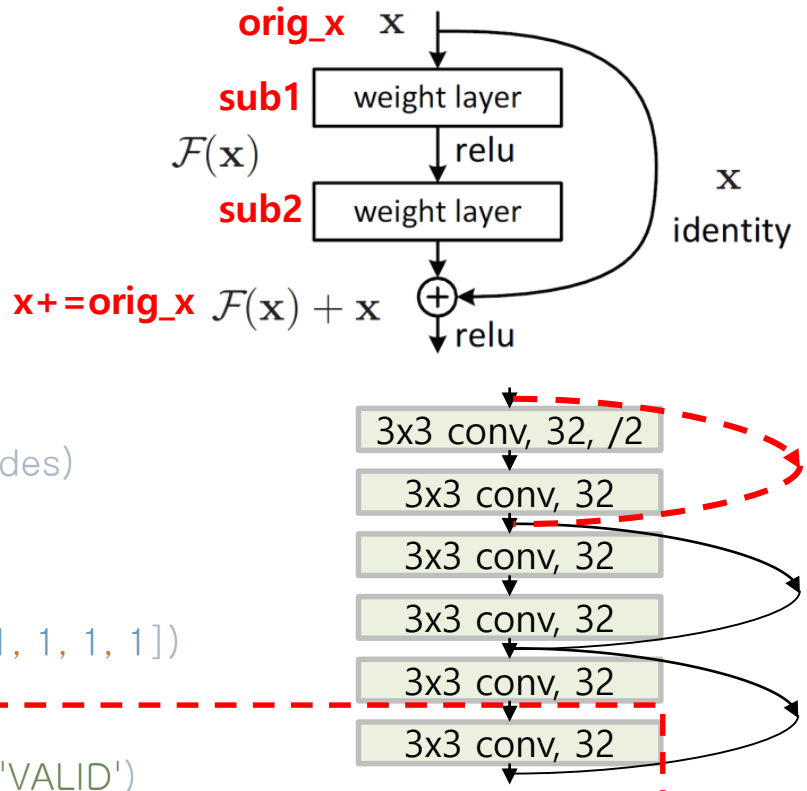
10개의 label 중 하나로 분류하기 위한
Fully connected layer



Residual

- resnet.py

```
def _residual(self, x, in_filter, out_filter, activate_before_residual=False, strides=[1, 1, 1, 1]):
    if activate_before_residual:
        with tf.variable_scope('common_activation'):
            x = self._batch_norm('init_bn', x)
            x = self._relu(x, self._relu_leakiness)
            orig_x = x
    else:
        with tf.variable_scope('residual_activation'):
            orig_x = x
            x = self._batch_norm('init_bn', x)
            x = self._relu(x, self._relu_leakiness)
    with tf.variable_scope('sub1'):
        x = self._conv('conv1', x, 3, in_filter, out_filter, strides)
    with tf.variable_scope('sub2'):
        x = self._batch_norm('bn2', x)
        x = self._relu(x, self._relu_leakiness)
        x = self._conv('conv2', x, 3, out_filter, out_filter, [1, 1, 1, 1])
    with tf.variable_scope('sub_add'):
        if in_filter != out_filter:
            orig_x = tf.nn.avg_pool(orig_x, strides, strides, 'VALID')
            orig_x = tf.pad(orig_x, [[0, 0], [0, 0], [0, 0], [(out_filter - in_filter) // 2, (out_filter - in_filter) //
2]])
        x += orig_x
    tf.logging.debug('image after unit %s', x.get_shape())
    return x
```

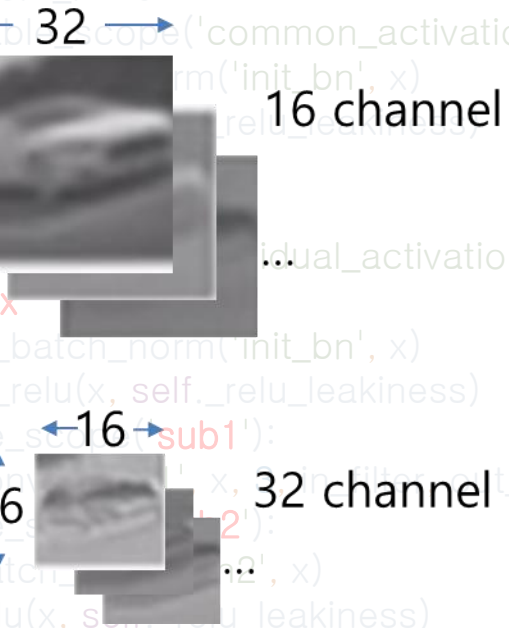


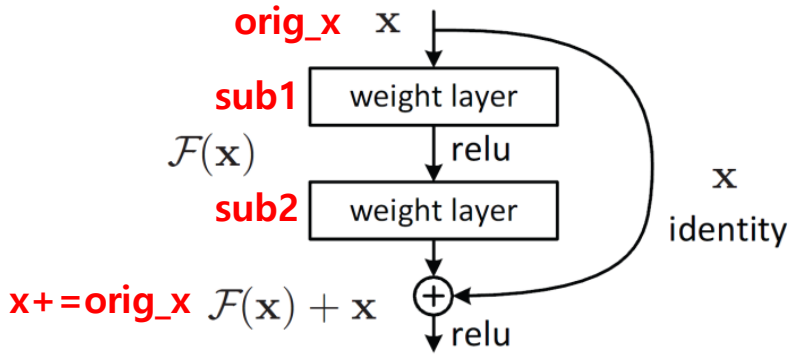
채널 크기가 변경됨에 따라
동일 한 크기의 feature map간에
Skip connection이 이루어지지 않을 때

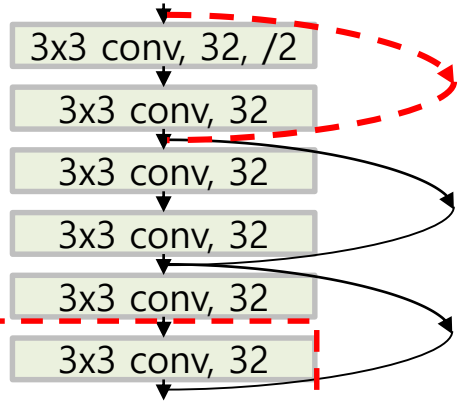
Residual

- resnet.py

```
def _residual(self, x, in_filter, out_filter, activate_before_residual=False, strides=[1, 1, 1, 1]):
    if activate_before_residual:
        with tf.variable_scope('common_activation'):
            x = self._batch_norm('init_bn', x)
            x = self._relu(x, self._relu_leakiness)
        orig_x = x
    else:
        with tf.variable_scope('residual_activation'):
            orig_x = x
            x = self._batch_norm('init_bn', x)
            x = self._relu(x, self._relu_leakiness)
    with tf.variable_scope('sub1'):
        x = self._conv('conv1', x, 3, in_filter, out_filter, strides)
    with tf.variable_scope('sub2'):
        x = self._batch_norm('bn2', x)
        x = self._relu(x, self._relu_leakiness)
        x = self._conv('conv2', x, 3, out_filter, out_filter, [1, 1, 1, 1])
    with tf.variable_scope('sub_add'):
        if in_filter != out_filter:
            orig_x = tf.nn.avg_pool(orig_x, strides, strides, 'VALID')
            orig_x = tf.pad(orig_x, [[0, 0], [0, 0], [0, 0], [(out_filter - in_filter) // 2, (out_filter - in_filter) // 2]])
        x += orig_x
    tf.logging.debug('image after unit %s', x.get_shape())
    return x
```







채널 크기가 변경됨에 따라
동일 한 크기의 feature map간에
Skip connection이 이루어지지 않을 때

Batch normalization

- resnet.py

```
def _relu(self, x, leakiness=0.0):
    return tf.where(tf.less(x, 0.0), leakiness * x, x, name='leaky_relu')
```

```
def _batch_norm(self, name, x):
    with tf.variable_scope(name):
        params_shape = [x.get_shape()[-1]]
        beta = tf.get_variable('beta', params_shape, tf.float32, initializer=tf.constant_initializer(0.0, tf.float32))
        gamma = tf.get_variable('gamma', params_shape, tf.float32, initializer=tf.constant_initializer(1.0,
tf.float32))
        mean, variance = tf.nn.moments(x, [0, 1, 2], name='moments')
        moving_mean = tf.get_variable('moving_mean', params_shape, tf.float32,
            initializer=tf.constant_initializer(0.0, tf.float32), trainable=False)
        moving_variance = tf.get_variable('moving_variance', params_shape, tf.float32,
            initializer=tf.constant_initializer(1.0, tf.float32), trainable=False)

        self.extra_train_ops.append(moving_averages.assign_moving_average(moving_mean, mean, 0.9))
        self.extra_train_ops.append(moving_averages.assign_moving_ave
0.9))

        y = tf.nn.batch_normalization(x, mean, variance, beta, gamma, 0.0
        y.set_shape(x.get_shape())
        return y
```

Input: Values of x over a mini-batch: $\mathcal{B} = \{x_{1...m}\}$;
Parameters to be learned: γ, β
Output: $\{y_i = \mathrm{BN}_{\gamma,\beta}(x_i)\}$

$$\mu_{\mathcal{B}} \leftarrow \frac{1}{m}\sum_{i=1}^{m} x_i \qquad \text{// mini-batch mean}$$

$$\sigma_{\mathcal{B}}^2 \leftarrow \frac{1}{m}\sum_{i=1}^{m}(x_i - \mu_{\mathcal{B}})^2 \qquad \text{// mini-batch variance}$$

$$\widehat{x}_i \leftarrow \frac{x_i - \mu_{\mathcal{B}}}{\sqrt{\sigma_{\mathcal{B}}^2 + \epsilon}} \qquad \text{// normalize}$$

$$y_i \leftarrow \gamma \widehat{x}_i + \beta \equiv \mathrm{BN}_{\gamma,\beta}(x_i) \qquad \text{// scale and shift}$$

Fully connected layer, weight decay

- resnet.py

```
def _fully_connected(self, x, out_dim):
    dim = tf.reduce_prod(x.get_shape()[1:]).eval()
    x = tf.reshape(x, [-1, dim])
    w = tf.get_variable('DW', [dim, out_dim],
        initializer=tf.uniform_unit_scaling_initializer(factor=1.0))
    b = tf.get_variable('biases', [out_dim], initializer=tf.constant_initializer())
    return tf.nn.xw_plus_b(x, w, b)
```

```
def _global_avg_pool(self, x):
    assert x.get_shape().ndims == 4
    return tf.reduce_mean(x, [1, 2])
```

```
def _decay(self):
    """L2 weight decay loss."""
    costs = []
    for var in tf.trainable_variables():
        if var.op.name.find(r'DW') > 0:
            costs.append(tf.nn.l2_loss(var))

    return tf.multiply(self._l2_reg_lambda, tf.add_n(costs))
```

Optimizer

- resnet_train.py

```
with tf.Graph().as_default():
    session_conf = tf.ConfigProto(
      allow_soft_placement=FLAGS.allow_soft_placement,
      log_device_placement=FLAGS.log_device_placement)
    sess = tf.Session(config=session_conf)
    with sess.as_default():
        resnet = ResNet(FLAGS)

        # Define Training procedure
        global_step = tf.Variable(0, name="global_step", trainable=False)
        decayed_lr = tf.train.exponential_decay(FLAGS.lr, global_step, 24000, FLAGS.lr_decay,
staircase=True)
        optimizer = tf.train.MomentumOptimizer(learning_rate=decayed_lr, momentum=0.9)
        grads_and_vars = optimizer.compute_gradients(resnet.loss)
        train_op = optimizer.apply_gradients(grads_and_vars, global_step=global_step)
        train_ops = [train_op] + resnet.extra_train_ops
        train_ops = tf.group(*train_ops)

        # Output directory for models and summaries
        timestamp = str(int(time.time()))
        out_dir = os.path.abspath(os.path.join(os.path.curdir, "runs", timestamp))
        print("Writing to {}\n".format(out_dir))
```

Summary, checkpoint

- resnet_train.py

```
# Summaries for loss and accuracy
loss_summary = tf.summary.scalar("loss", resnet.loss)
acc_summary = tf.summary.scalar("accuracy", resnet.accuracy)
# Train Summaries
train_summary_op = tf.summary.merge([loss_summary, acc_summary])
train_summary_dir = os.path.join(out_dir, "summaries", "train")
train_summary_writer = tf.summary.FileWriter(train_summary_dir, sess.graph)
# Dev summaries
dev_summary_op = tf.summary.merge([loss_summary, acc_summary])
dev_summary_dir = os.path.join(out_dir, "summaries", "dev")
dev_summary_writer = tf.summary.FileWriter(dev_summary_dir, sess.graph)

# Checkpoint directory. Tensorflow assumes this directory already exists so we need to create it
checkpoint_dir = os.path.abspath(os.path.join(out_dir, "checkpoints"))
checkpoint_prefix = os.path.join(checkpoint_dir, "model")
if not os.path.exists(checkpoint_dir):
    os.makedirs(checkpoint_dir)
saver = tf.train.Saver(tf.global_variables(), max_to_keep=FLAGS.num_checkpoints)
```

Train & dev step

- resnet_train.py

```
sess.run(tf.global_variables_initializer())
def train_step(x_batch, y_batch):
    feed_dict = {
      resnet.X: x_batch,
      resnet.Y: y_batch
    }
    _, step, lr, summaries, loss, accuracy = sess.run(
        [train_ops, global_step, decayed_lr, train_summary_op, resnet.loss, resnet.accuracy],
        feed_dict)
    time_str = datetime.datetime.now().isoformat()
    print("{}: step {}, lr {}, loss {:g}, acc {:g}".format(time_str, step, lr, loss, accuracy))
    train_summary_writer.add_summary(summaries, step)
def dev_step(x_batch, y_batch, writer=None):
feed_dict = {
      resnet.X: x_batch,
      resnet.Y: y_batch
    }
    step, summaries, loss, accuracy = sess.run(
        [global_step, dev_summary_op, resnet.loss, resnet.accuracy],
        feed_dict)
    time_str = datetime.datetime.now().isoformat()
    print("{}: step {}, loss {:g}, acc {:g}".format(time_str, step, loss, accuracy))
    if writer:
        writer.add_summary(summaries, step)
    return accuracy
```

Batch, Training

- resnet_train.py

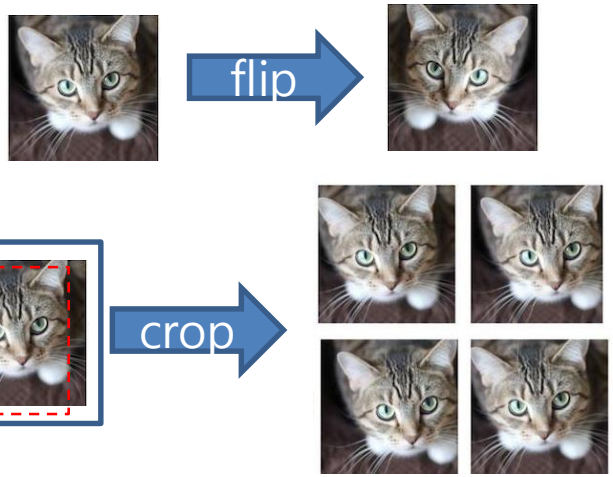
```
batches = dh.batch_iter(x_train, y_train, FLAGS.batch_size, FLAGS.num_epochs)
max = 0
for batch in batches:
    x_batch, y_batch = zip(*batch)
    train_step(x_batch, y_batch)
    current_step = tf.train.global_step(sess, global_step)
    if current_step % FLAGS.evaluate_every == 0:
        print("₩nEvaluation:")
        accuracy = dev_step(x_val, y_val, writer=dev_summary_writer)
        print("")
        if accuracy > max:
            max = accuracy
            path = saver.save(sess, checkpoint_prefix, global_step=current_step)
            print("Saved model checkpoint to {}₩n".format(path))
```

Batch

- data_helpers.py

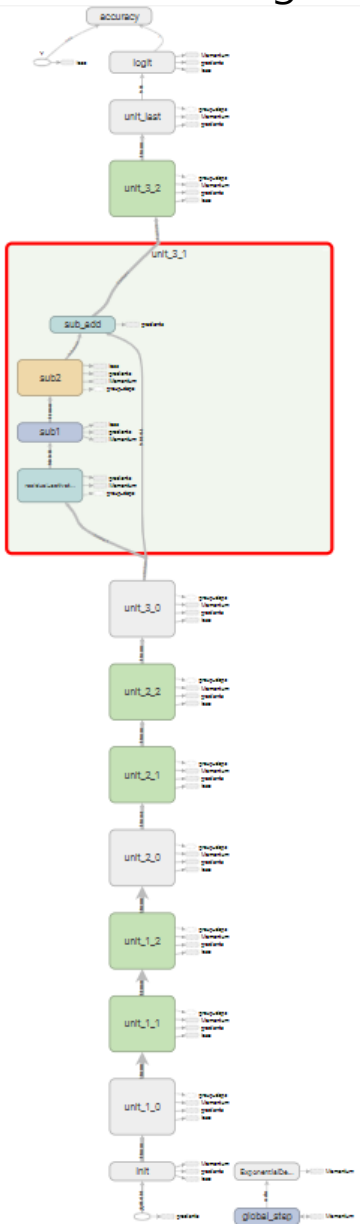
```
def batch_iter(x, y , batch_size, num_epochs, shuffle=True):
    num_batches_per_epoch = int((len(x) - 1) / batch_size) + 1
    for epoch in range(num_epochs):
        shuffle_indices = np.random.permutation(np.arange(len(x)))
        shuffled_x = x[shuffle_indices]
        shuffled_y = y[shuffle_indices]
        for batch_num in range(num_batches_per_epoch):
            start_index = batch_num * batch_size
            end_index = min((batch_num + 1) * batch_size, len(y))
            yield list(zip(data_augmentation(shuffled_x[start_index:end_index], 4),
shuffled_y[start_index:end_index]))
def data_augmentation (x_batch, padding=None):
    for i in range(len(x_batch)):
        if bool(random.getrandbits(1)):
            x_batch[i] = np.fliplr(x_batch[i])
    oshape = np.shape(x_batch[0])
    if padding:
        oshape = (oshape[0] + 2 * padding, oshape[1] + 2 * padding, 3)
    new_batch = []
    npad = ((padding, padding), (padding, padding), (0, 0))
    for i in range(len(x_batch)):
        new_batch.append(x_batch[i])
        if padding:
            new_batch[i] = np.lib.pad(x_batch[i], pad_width=npad, mode='constant', constant_values=0)
        nh = random.randint(0, oshape[0] - 32)
        nw = random.randint(0, oshape[1] - 32)
        new_batch[i] = new_batch[i][nh:nh + 32, nw:nw + 32]
    return new_batch
```

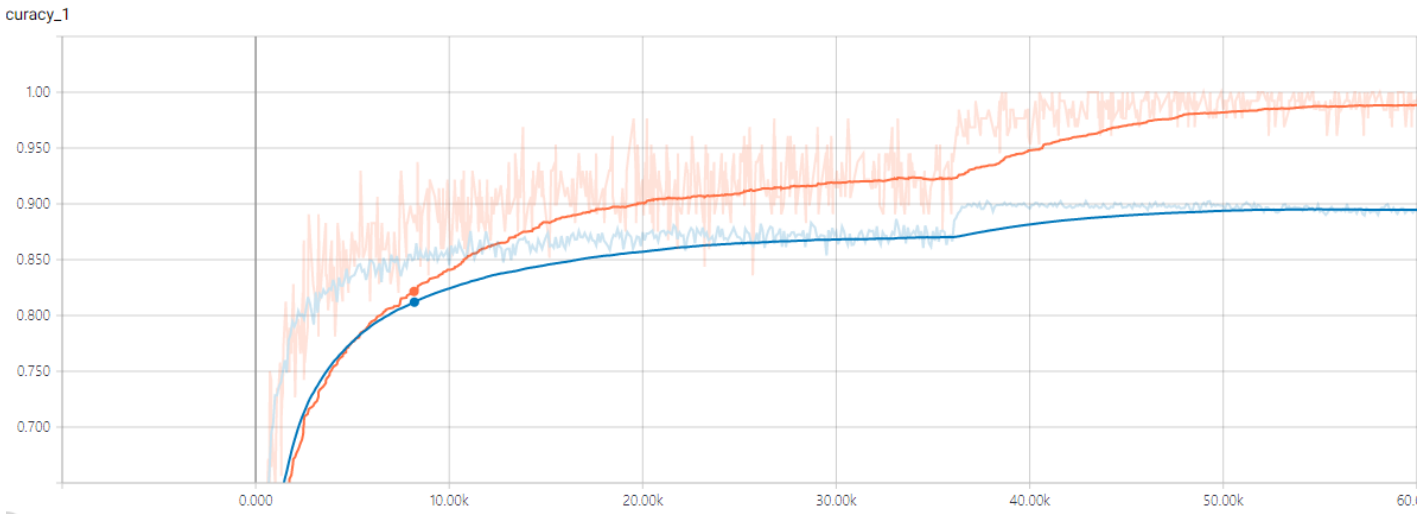
학습 데이터를 늘리기 위해
좌우 대칭 및 사진의 일부영역 잘라내기



Tensorboard

tensorboard --logdir=C:₩Users₩82102₩PycharmProjects₩aischool₩CIFAR₩runs₩1580556863





AI School 6기 7주차

CNN 모델을 활용한 영화리뷰 평점 예측

CNN for text classification

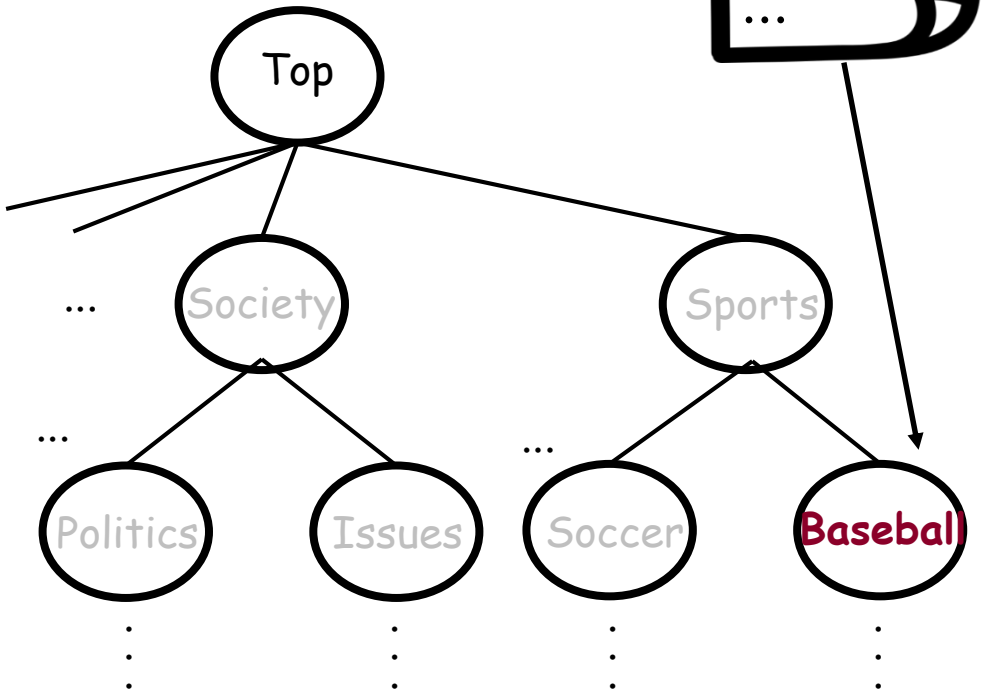
- CNN for sentence classification [Kim et al., 2014]

Five stars!

The Pitcher ...

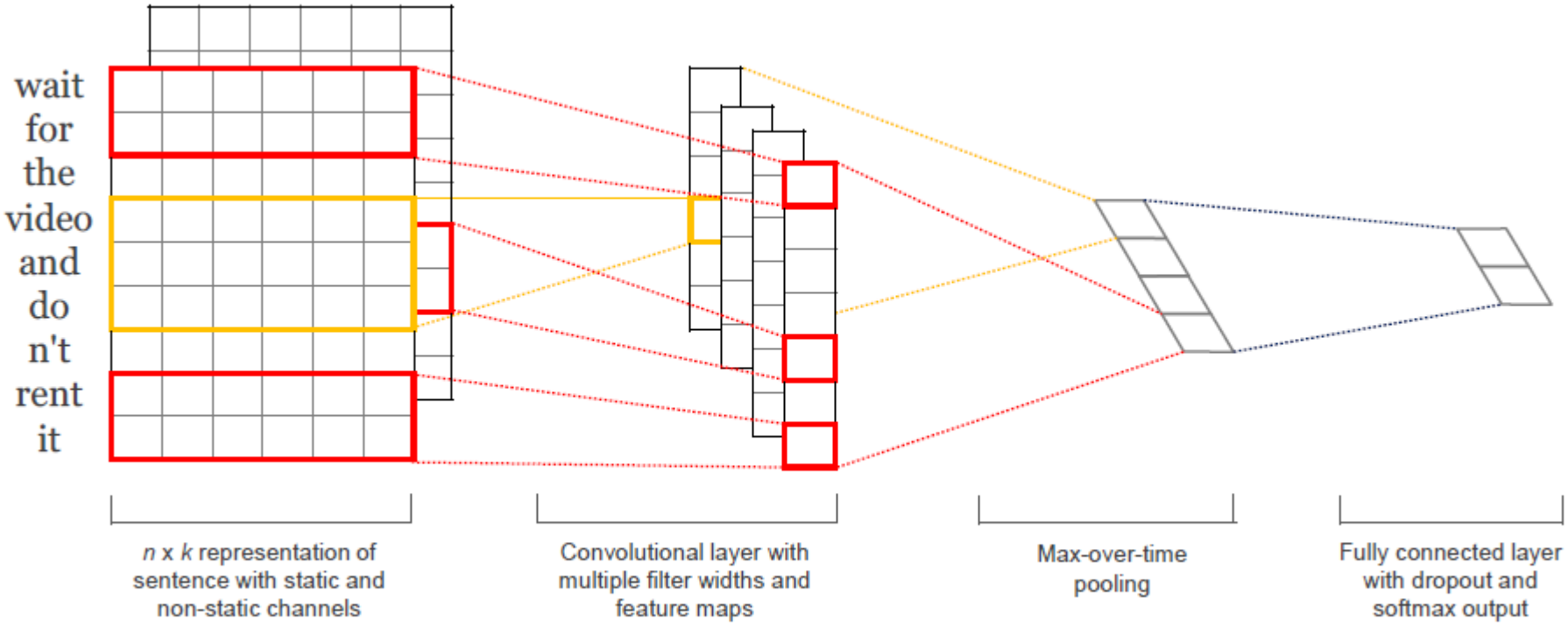
Positive
Negative
Economy
Sports
Weather
...

The Pitcher ...



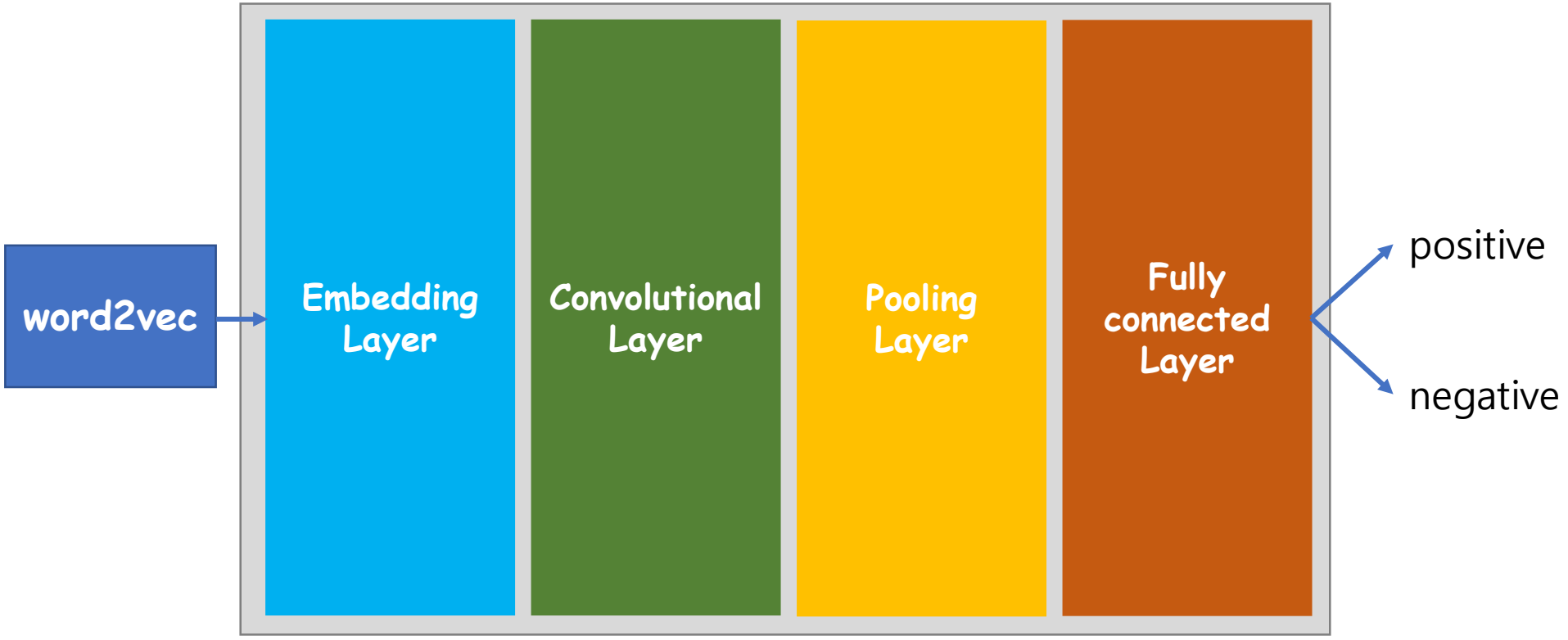
CNN for text classification

- Model overview



CNN for text classification

- Model overview



Word2vec

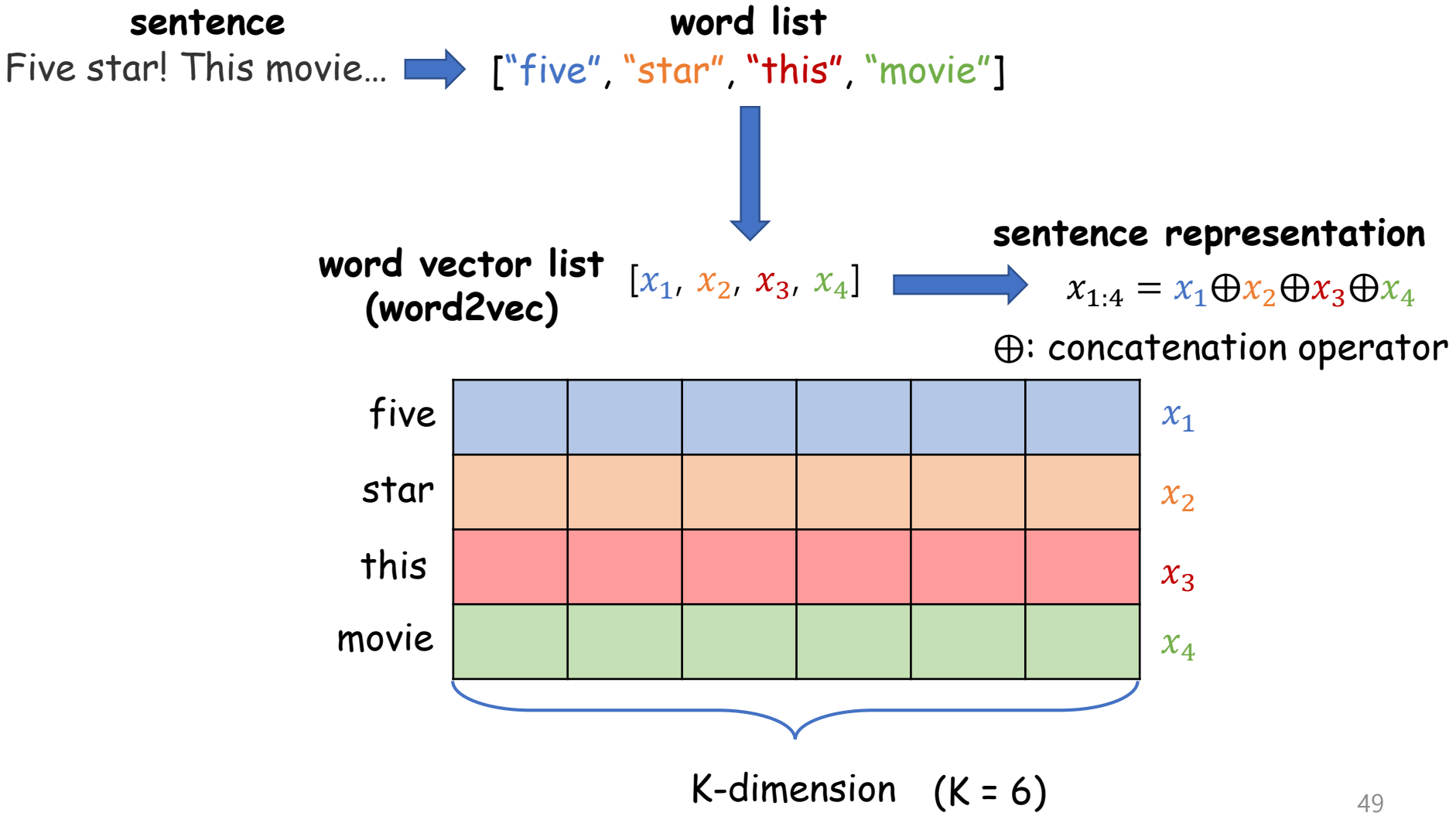
apple = [0.1, 0.5, -1.2, 3.0, 0.4]

fruit = [1.0, 0.3, -0.3, 0.8, -2.1]

car = [-3.5, 0.4, 0.1, 0.5, -0.8]

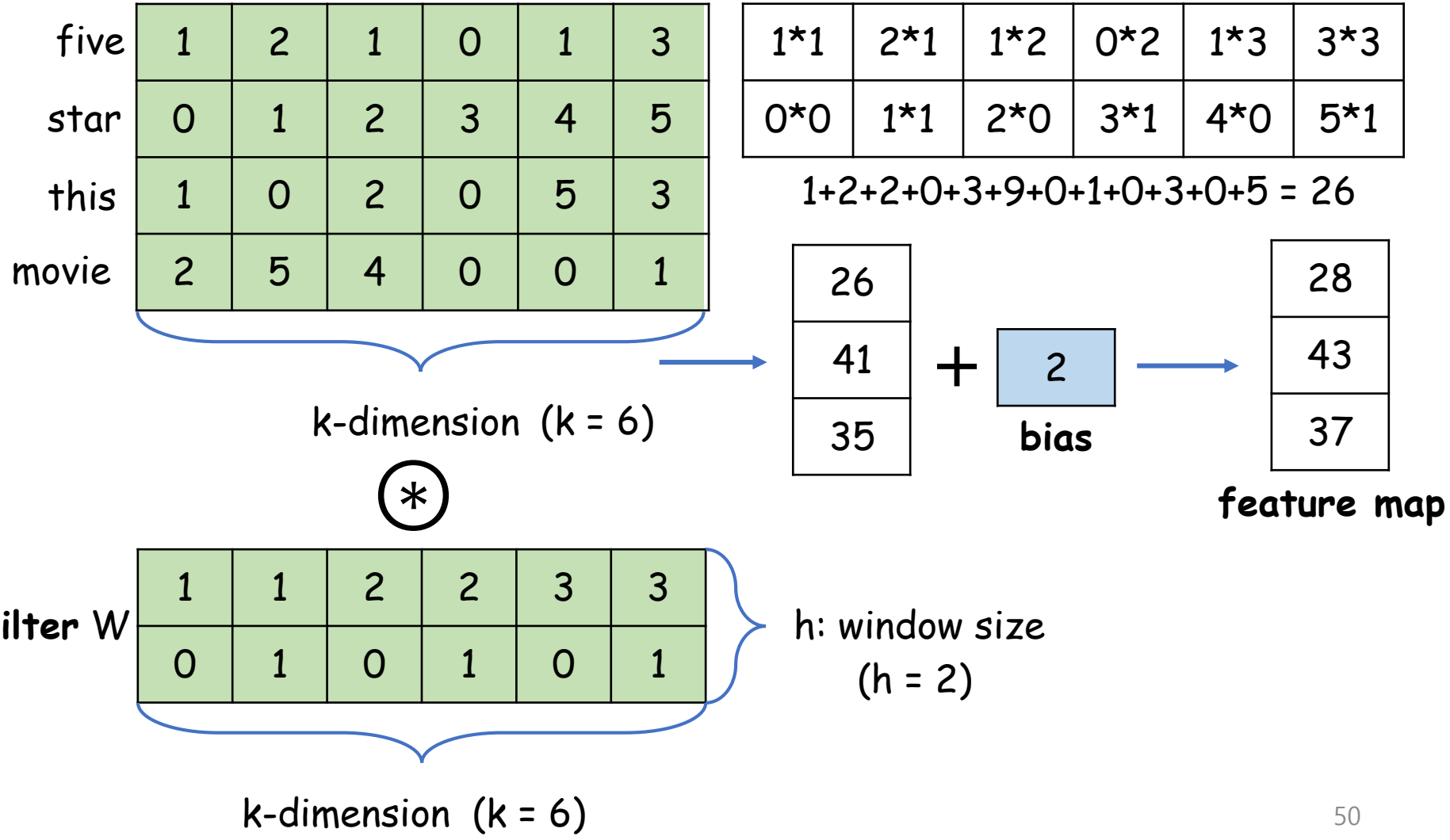
CNN for text classification

- Word2vec & Embedding layer



CNN for text classification

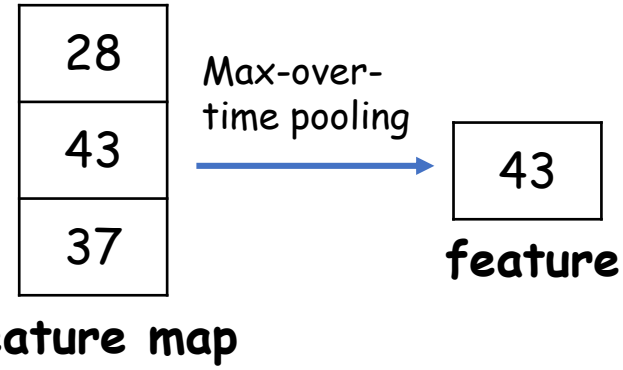
- Convolutional layer



CNN for text classification

- Pooling layer

five	1	2	1	0	1	3
star	0	1	2	3	4	5
this	1	0	2	0	5	3
movie	2	5	4	0	0	1

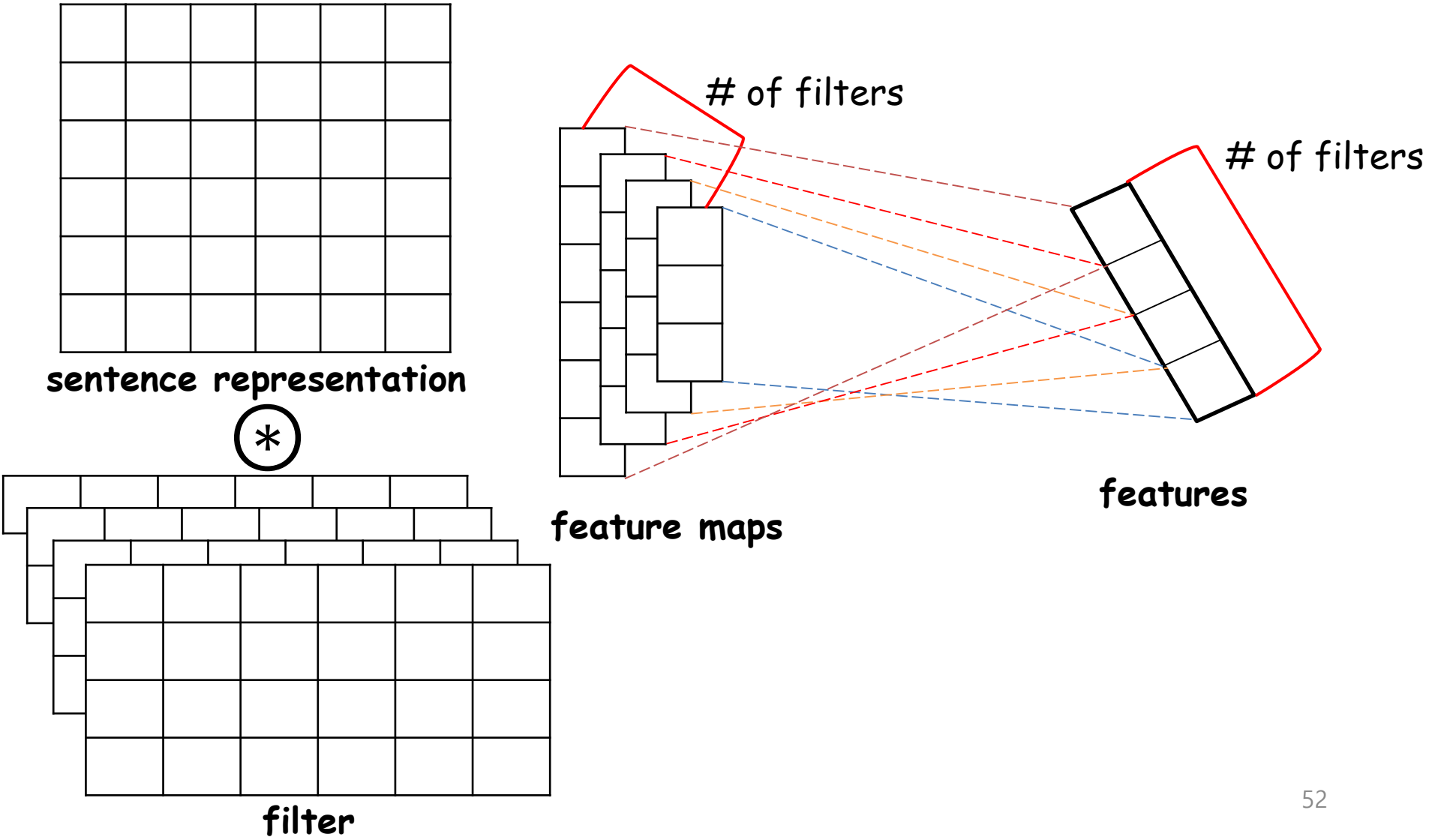


filter W	1	1	2	2	3	3
	0	1	0	1	0	1

One filter -> **One** feature
Multiple filter -> **Multiple** feature

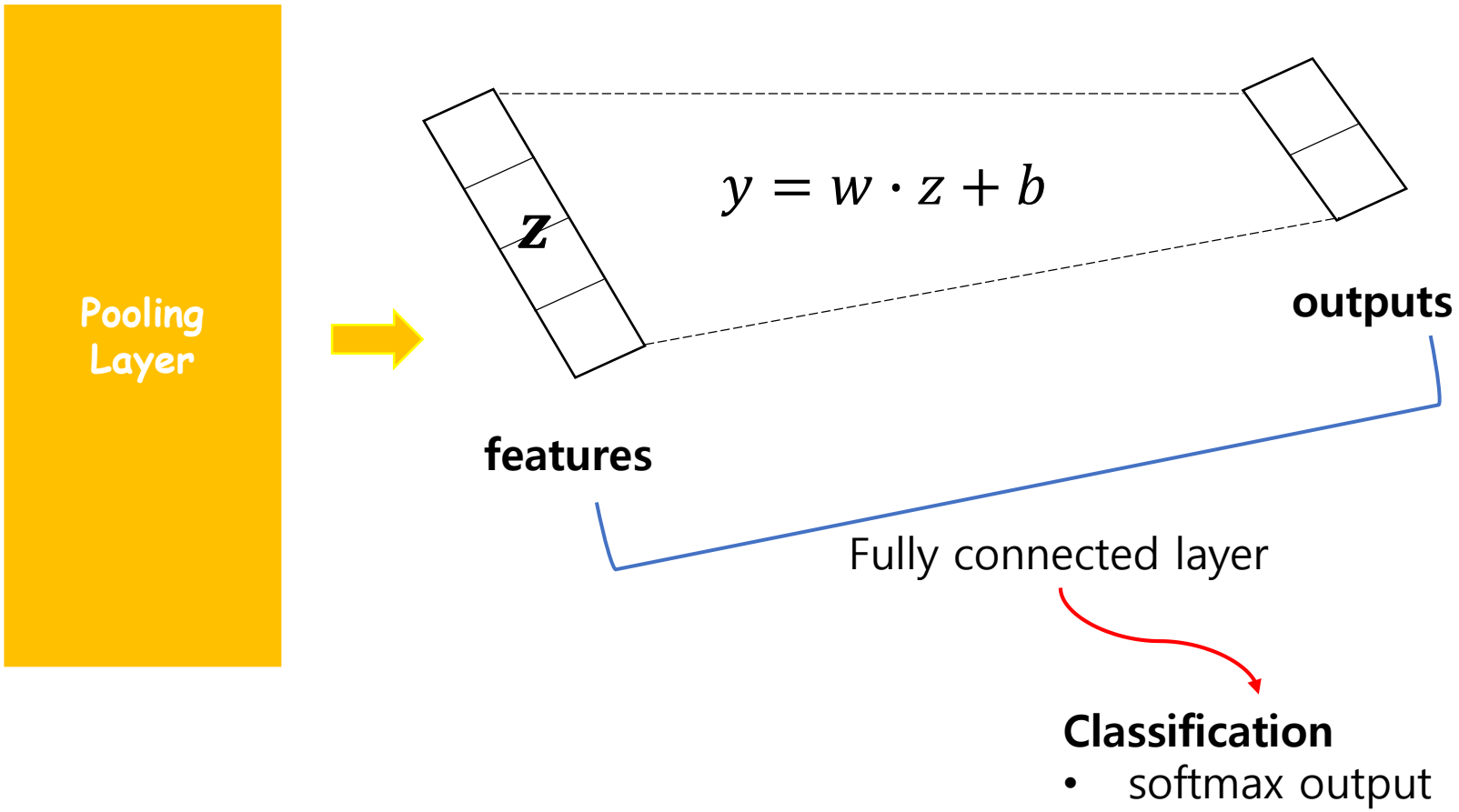
CNN for text classification

- Pooling layer



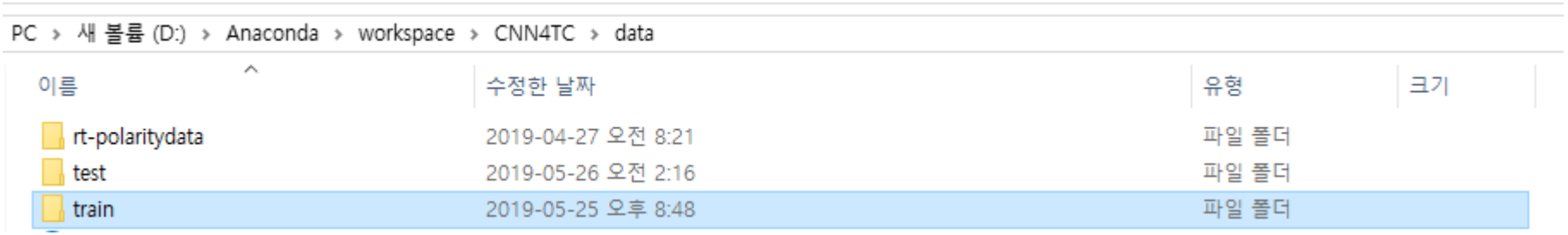
CNN for text classification

- Fully connected layer



CNN 분류기 학습

- 학습 데이터 다운로드



CNN 분류기 학습

- Import

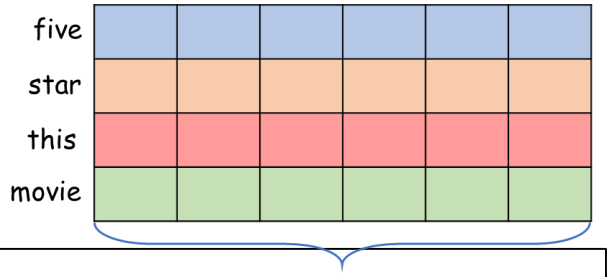
train.py

```
import tensorflow as tf
import numpy as np
import os
import time
import datetime
import CNN4TC.data_helpers as dh
from CNN4TC.text_cnn import TextCNN
from tensorflow.contrib import learn
```

data_helpers.py

```
import numpy as np
import re
import glob
```

Hyperparameters



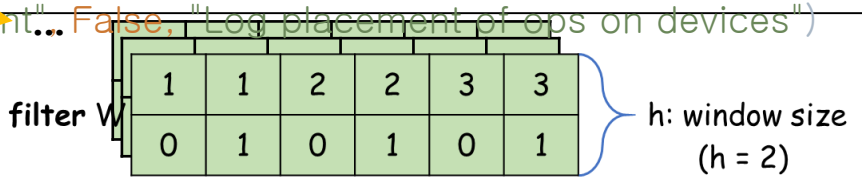
- train.py

```
# Data loading params
tf.flags.DEFINE_float("dev_sample_percentage", .1, "Percentage of the training data to use for validation")
tf.flags.DEFINE_string("imdb_pos_data_file", "./data/train/pos/*", "Data source for the positive data.")
tf.flags.DEFINE_string("imdb_neg_data_file", "./data/train/neg/*", "Data source for the negative data.")
# Model Hyperparameters
tf.flags.DEFINE_integer("embedding_dim", 128, "Dimensionality of word embedding (default: 128)")
tf.flags.DEFINE_string("filter_sizes", "2,3,4", "Comma-separated filter sizes (N-gram) (default: '3,4,5')")
tf.flags.DEFINE_integer("num_filters", 128, "Number of filters per filter size (default: 128)")
tf.flags.DEFINE_float("lr", 5e-4, "learning rate (default: 0.001)")
tf.flags.DEFINE_float("dropout_keep_prob", 0.6, "Dropout keep probability (default: 0.5)")
tf.flags.DEFINE_float("l2_reg_lambda", 0.000000001, "L2 regularization lambda (default: 0.0)")
# Training parameters
tf.flags.DEFINE_integer("batch_size", 64, "Batch Size (default: 64)")
tf.flags.DEFINE_integer("num_epochs", 20, "Number of training epochs (default: 200)")
tf.flags.DEFINE_integer("evaluate_every", 100, "Evaluate model on dev set after this many steps (default:
100)")
tf.flags.DEFINE_integer("checkpoint_every", 100, "Save model after this many steps (iterations) (default:
100)")
tf.flags.DEFINE_integer("num_checkpoints", 3, "Number of checkpoints to store (default: 5)")
# Misc Parameters
tf.flags.DEFINE_boolean("allow_soft_placement", True, "Allow device soft device placement")
tf.flags.DEFINE_boolean("log_device_placement", False, "Log placement of ops on devices")
FLAGS = tf.flags.FLAGS
```

단어를 표현하는 벡터의 크기

Filter의 높이
or
Window size
or
N-gram

Filter 종류별 개수



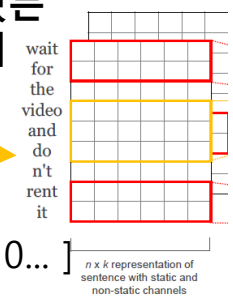
Data loading & preprocessing

- train.py

```
# Load data
print("Loading data...")
x_text, y = dh.load_imdb_data_and_labels(FLAGS.imdb_pos_data_file, FLAGS.imdb_neg_data_file)

# Build vocabulary
max_document_length = max([len(x.split(" ")) for x in x_text])
print("max_document_length: ", max_document_length) #298
vocab_processor = learn.preprocessing.VocabularyProcessor(max_document_length)
x = np.array(list(vocab_processor.fit_transform(x_text)))
np.random.seed(10)
shuffle_indices = np.random.permutation(np.arange(len(y)))
x_shuffled = x[shuffle_indices]
y_shuffled = y[shuffle_indices]
# Split train/test set
dev_sample_index = -1 * int(FLAGS.dev_sample_percentage * float(len(y)))
x_train, x_dev = x_shuffled[:dev_sample_index], x_shuffled[dev_sample_index:]
y_train, y_dev = y_shuffled[:dev_sample_index], y_shuffled[dev_sample_index:]

del x, y, x_shuffled, y_shuffled

print("Vocabulary Size: {:d}".format(len(vocab_processor.vocabulary_)))
print("Train/Dev split: {:d}/{:d}".format(len(y_train), len(y_dev)))
```

모델이 처리할 수 있는 문장의 최대 길이

five star this movie is good--> [8 379 3 47574 2 45 0 0 0 0 0 0 0 0 0 0...]



IMDB data loading

- data_helpers.py

```
def load_imdb_data_and_labels(pos_file, neg_file):
    # Load data from files
    pos_list = glob.glob(pos_file) #load file list
    pos_final = []# sentence list

    for pos in pos_list:
        x_text = list(open(pos, "r", encoding='UTF8').readlines())
        x_text = [clean_str(sent) for sent in x_text]
        pos_final = pos_final + x_text

    neg_list = glob.glob(neg_file)
    neg_final = []

    for neg in neg_list:
        x_text = list(open(neg, "r", encoding='UTF8').readlines())
        x_text = [clean_str(sent) for sent in x_text]
        neg_final = neg_final + x_text

    positive_labels = [[0, 1] for _ in pos_final] #[[0,1], [0,1], [0,1], [0,1], [0,1], [0,1],...]
    negative_labels = [[1, 0] for _ in neg_final] #[[1,0], [1,0], [1,0], [1,0], [1,0], [1,0],...]

    y = np.concatenate([positive_labels, negative_labels], 0) ##[[0,1], [0,1], [0,1], [0,1], [0,1],
[0,1],...[1,0], [1,0]
    x_final = pos_final + neg_final
    return [x_final, y]
```

TextCNN class & input

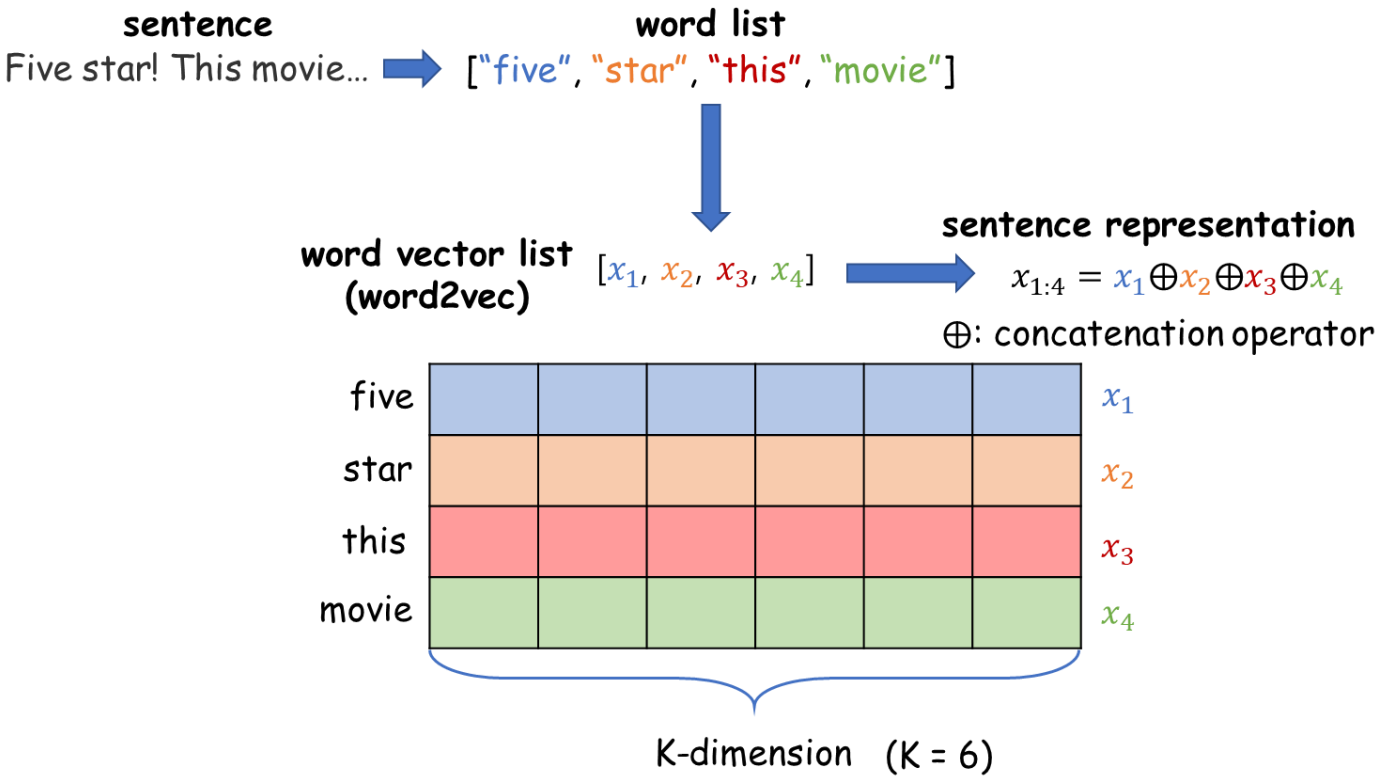
- text_cnn.py

```
import tensorflow as tf


class TextCNN(object):
    def __init__(self, sequence_length, num_classes, vocab_size, embedding_size, filter_sizes,
num_filters, l2_reg_lambda=0.0):

        # Placeholders for input, output and dropout
        self.input_x = tf.placeholder(tf.int32, [None, sequence_length], name="input_x")
        self.input_y = tf.placeholder(tf.float32, [None, num_classes], name="input_y")#pos: [0 1] neg: [1
0]
        self.dropout_keep_prob = tf.placeholder(tf.float32, name="dropout_keep_prob") #training: 0.5
#test: 1.0



        # Keeping track of l2 regularization loss (optional)
        l2_loss = tf.constant(0.0)
```

Embedding layer

- text_cnn.py

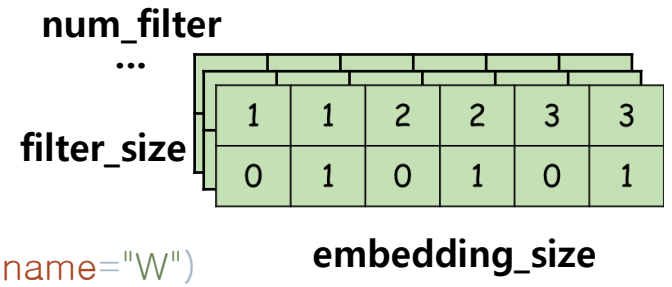
```
# Embedding layer
with tf.device('/gpu:0'), tf.name_scope("embedding"):
    self.W = tf.Variable(tf.random_uniform([vocab_size, embedding_size], -1.0, 1.0), name="W")
    self.embedded_chars = tf.nn.embedding_lookup(self.W, self.input_x) #[batch, embedding_dim_, sequenth_length]
    self.embedded_chars_expanded = tf.expand_dims(self.embedded_chars, -1)#[batch, embedding_dim_, sequenth_length, 1]
```

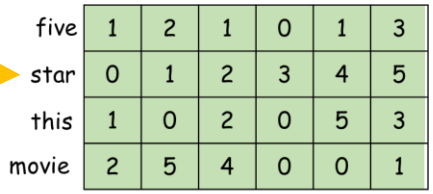


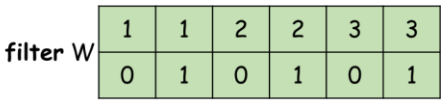
Convolutional layer

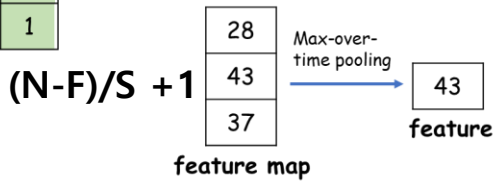
- text_cnn.py

```
# Create a convolution + maxpool layer for each filter size
pooled_outputs = []
for i, filter_size in enumerate(filter_sizes):
    with tf.name_scope("conv-maxpool-%s" % filter_size):
        # Convolution Layer
        filter_shape = [filter_size, embedding_size, 1, num_filters]
        W = tf.Variable(tf.truncated_normal(filter_shape, stddev=0.1), name="W")
        b = tf.Variable(tf.constant(0.1, shape=[num_filters]), name="b")
        conv = tf.nn.conv2d(
            self.embedded_chars_expanded,
            W,
            strides=[1, 1, 1, 1],
            padding="VALID",
            name="conv")
        # Apply nonlinearity
        h = tf.nn.relu(tf.nn.bias_add(conv, b), name="relu")
        # Maxpooling over the outputs
        pooled = tf.nn.max_pool(
            h,
            ksize=[1, sequence_length - filter_size + 1, 1, 1], #mnist [1,2,2,1]
            strides=[1, 1, 1, 1],
            padding='VALID',
            name="pool")
        pooled_outputs.append(pooled)
```





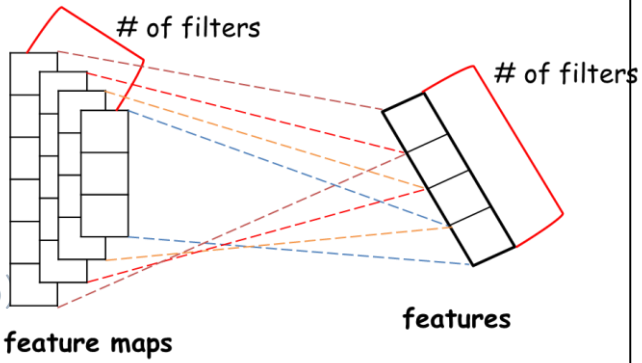


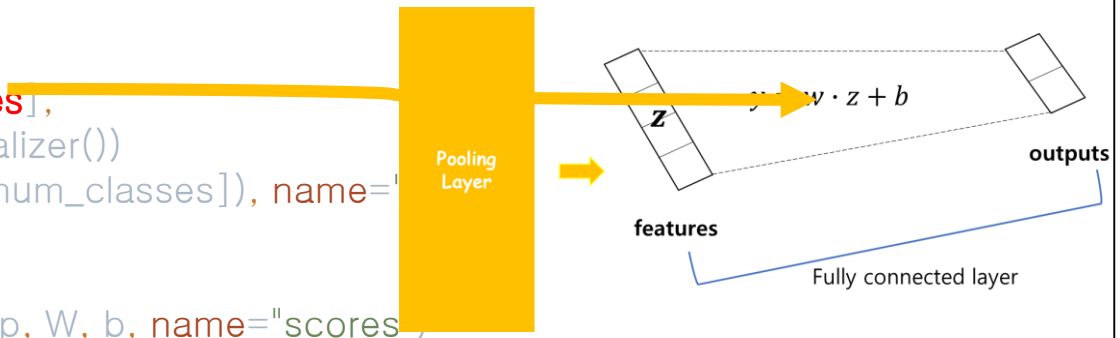


Fully connected layer

- text_cnn.py

```
# Combine all the pooled features
num_filters_total = num_filters * len(filter_sizes)
self.h_pool = tf.concat(pooled_outputs, 3)
self.h_pool_flat = tf.reshape(self.h_pool, [-1, num_filters_total])

with tf.name_scope("dropout"):
    self.h_drop = tf.nn.dropout(self.h_pool_flat, self.dropout_keep_prob)

with tf.name_scope("output"):
    W = tf.get_variable(
        "W",
        shape=[num_filters_total, num_classes],
        initializer=tf.contrib.layers.xavier_initializer())
    b = tf.Variable(tf.constant(0.1, shape=[num_classes]), name="
    l2_loss += tf.nn.l2_loss(W)
    l2_loss += tf.nn.l2_loss(b)
    self.scores = tf.nn.xw_plus_b(self.h_drop, W, b, name="scores")
    self.predictions = tf.argmax(self.scores, 1, name="predictions")

with tf.name_scope("loss"):
    losses = tf.nn.softmax_cross_entropy_with_logits(logits=self.scores, labels=self.input_y)
    self.loss = tf.reduce_mean(losses) + l2_reg_lambda * l2_loss

with tf.name_scope("accuracy"):
    correct_predictions = tf.equal(self.predictions, tf.argmax(self.input_y, 1))
    self.accuracy = tf.reduce_mean(tf.cast(correct_predictions, "float"), name="accuracy")
```





Optimizer

- train.py

```
with tf.Graph().as_default():
    session_conf = tf.ConfigProto(
      allow_soft_placement=FLAGS.allow_soft_placement,
      log_device_placement=FLAGS.log_device_placement)
    sess = tf.Session(config=session_conf)
    with sess.as_default():
        cnn = TextCNN(
            sequence_length=x_train.shape[1],
            num_classes=y_train.shape[1],
            vocab_size=len(vocab_processor.vocabulary_),
            embedding_size=FLAGS.embedding_dim,
            filter_sizes=list(map(int, FLAGS.filter_sizes.split(","))),
            num_filters=FLAGS.num_filters,
            l2_reg_lambda=FLAGS.l2_reg_lambda)

        # Define Training procedure
        global_step = tf.Variable(0, name="global_step", trainable=False)
        optimizer = tf.train.AdamOptimizer(FLAGS.lr)
        #optimizer = tf.train.AdagradOptimizer(FLAGS.lr)
        grads_and_vars = optimizer.compute_gradients(cnn.loss)
        train_op = optimizer.apply_gradients(grads_and_vars, global_step=global_step)
```

Summaries

- train.py

```
# Keep track of gradient values and sparsity (optional)
grad_summaries = []
for g, v in grads_and_vars:
    if g is not None:
        grad_hist_summary = tf.summary.histogram("{}/grad/hist".format(v.name), g)
        sparsity_summary = tf.summary.scalar("{}/grad/sparsity".format(v.name), tf.nn.zero_fraction(g))
        grad_summaries.append(grad_hist_summary)
        grad_summaries.append(sparsity_summary)
grad_summaries_merged = tf.summary.merge(grad_summaries)

# Output directory for models and summaries
timestamp = str(int(time.time()))
out_dir = os.path.abspath(os.path.join(os.path.curdir, "runs", timestamp))
print("Writing to {}₩n".format(out_dir))
# Summaries for loss and accuracy
loss_summary = tf.summary.scalar("loss", cnn.loss)
acc_summary = tf.summary.scalar("accuracy", cnn.accuracy)
# Train Summaries
train_summary_op = tf.summary.merge([loss_summary, acc_summary, grad_summaries_merged])
train_summary_dir = os.path.join(out_dir, "summaries", "train")
train_summary_writer = tf.summary.FileWriter(train_summary_dir, sess.graph)
# Dev summaries
dev_summary_op = tf.summary.merge([loss_summary, acc_summary])
dev_summary_dir = os.path.join(out_dir, "summaries", "dev")
dev_summary_writer = tf.summary.FileWriter(dev_summary_dir, sess.graph)
```

Checkpoint, Save vocabulary

- train.py

```
# Checkpoint directory. Tensorflow assumes this directory already exists so we need to create it
checkpoint_dir = os.path.abspath(os.path.join(out_dir, "checkpoints"))
checkpoint_prefix = os.path.join(checkpoint_dir, "model")
if not os.path.exists(checkpoint_dir):
    os.makedirs(checkpoint_dir)
saver = tf.train.Saver(tf.global_variables(), max_to_keep=FLAGS.num_checkpoints)

# Write vocabulary
vocab_processor.save(os.path.join(out_dir, "vocab"))

# Initialize all variables
sess.run(tf.global_variables_initializer())
```

Train & dev step

- train.py

```
def train_step(x_batch, y_batch):
    feed_dict = {
      cnn.input_x: x_batch,
      cnn.input_y: y_batch,
      cnn.dropout_keep_prob: FLAGS.dropout_keep_prob
    }
    _, step, summaries, loss, accuracy = sess.run(
        [train_op, global_step, train_summary_op, cnn.loss, cnn.accuracy],
        feed_dict)
    time_str = datetime.datetime.now().isoformat()
    print("{}: step {}, loss {:g}, acc {:g}".format(time_str, step, loss, accuracy))
    train_summary_writer.add_summary(summaries, step)
def dev_step(x_batch, y_batch, writer=None):
    feed_dict = {
      cnn.input_x: x_batch,
      cnn.input_y: y_batch,
      cnn.dropout_keep_prob: 1.0
    }
    step, summaries, loss, accuracy = sess.run(
        [global_step, dev_summary_op, cnn.loss, cnn.accuracy],
        feed_dict)
    time_str = datetime.datetime.now().isoformat()
    print("{}: step {}, loss {:g}, acc {:g}".format(time_str, step, loss, accuracy))
    if writer:
        writer.add_summary(summaries, step)
    return accuracy
```

Batch, Training

- train.py

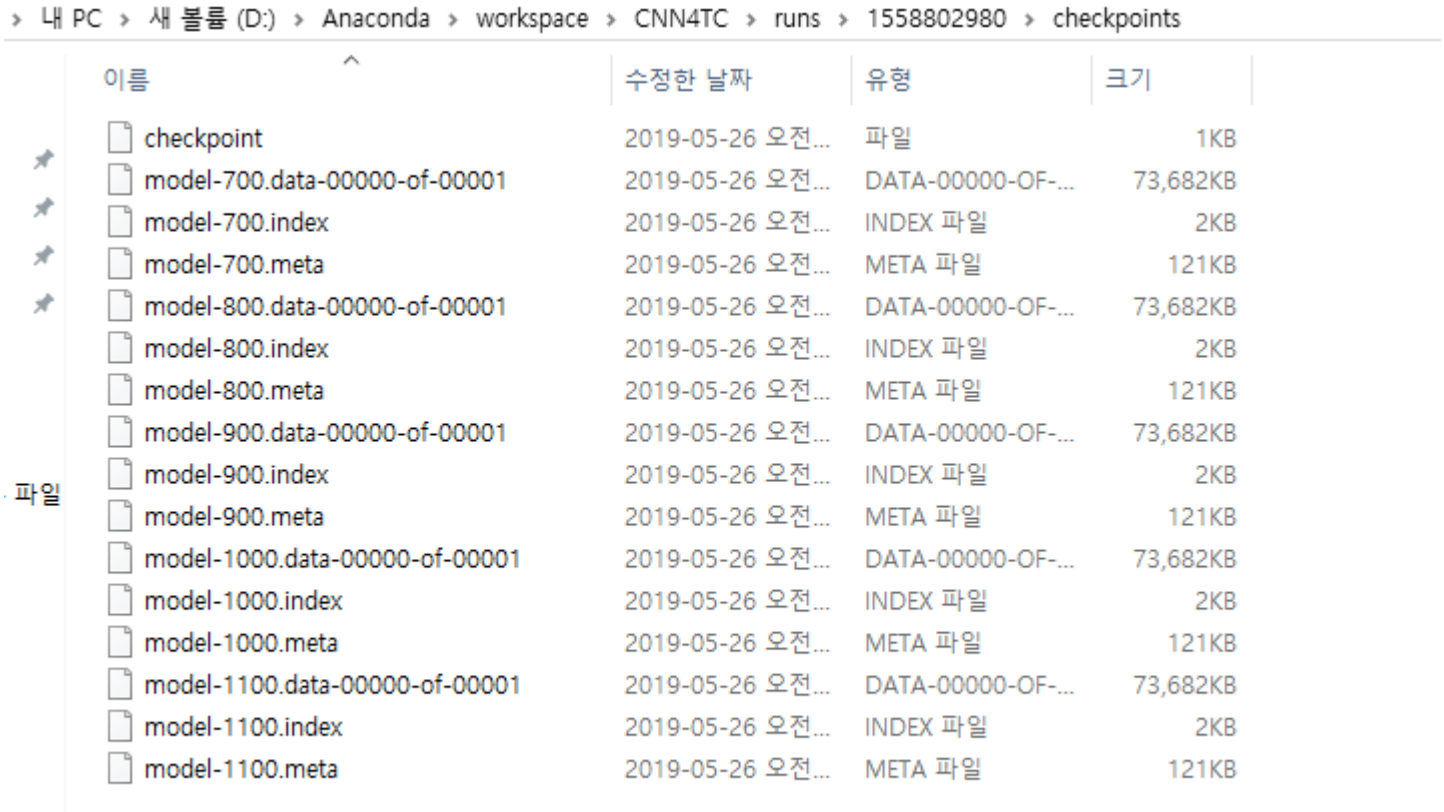
```
batches = dh.batch_iter(list(zip(x_train, y_train)), FLAGS.batch_size, FLAGS.num_epochs)
max = 0
for batch in batches:
    x_batch, y_batch = zip(*batch)
    train_step(x_batch, y_batch)
    current_step = tf.train.global_step(sess, global_step)
    if current_step % FLAGS.evaluate_every == 0:
        accuracy = dev_step(x_dev, y_dev, writer=dev_summary_writer)
        if accuracy > max:
            max = accuracy
            path = saver.save(sess, checkpoint_prefix, global_step=current_step)
            print("Saved model checkpoint to {}₩n".format(path))
```

- data_helpers.py

```
def batch_iter(data, batch_size, num_epochs, shuffle=True):
    data = np.array(data)
    data_size = len(data)
    num_batches_per_epoch = int((len(data)-1)/batch_size) + 1
    for epoch in range(num_epochs):
        if shuffle:
            shuffle_indices = np.random.permutation(np.arange(data_size))
            shuffled_data = data[shuffle_indices]
        else: shuffled_data = data
        for batch_num in range(num_batches_per_epoch):
            start_index = batch_num * batch_size
            end_index = min((batch_num + 1) * batch_size, data_size)
            yield shuffled_data[start_index:end_index]
```

CNN 분류기 학습

- ./run/생성시간/checkpoints- 학습 모델 확인




```
Evaluation:
2019-05-26T02:22:50.357046: step 1200, loss 0.37375, acc 0.838
```

CNN 분류기 평가

- eval.py

```
tf.flags.DEFINE_string("imdb_pos_data_file", "./data/test/pos/*", "Data source for the positive data.")
tf.flags.DEFINE_string("imdb_neg_data_file", "./data/test/neg/*", "Data source for the negative data.")
tf.flags.DEFINE_string("checkpoint_dir", "./runs/1522115047/checkpoints", "Checkpoint directory from training run")
tf.flags.DEFINE_boolean("eval_test", True, "Evaluate on all test data")
x_raw, y_test = dh.load_imdb_data_and_labels(FLAGS.imdb_pos_data_file, FLAGS.imdb_neg_data_file)
```

CNN 분류기 평가 (실제 imdb data)

- Imdb_eval.py

```
tf.flags.DEFINE_string("real_imdb_x_data_file", "./data/review.txt", "Data source for the positive data.")
tf.flags.DEFINE_string("real_imdb_t__data_file", "./data/score.txt", "Data source for the negative data.")
tf.flags.DEFINE_string("checkpoint_dir", "./runs/1558802980/checkpoints", "Checkpoint directory from training run")

x_raw, y_test = dh.load_real_imdb_data_and_labels(FLAGS.real_imdb_x_data_file, FLAGS.real_imdb_t_data_file)
```

CNN 분류기 평가 (실제 imdb data)

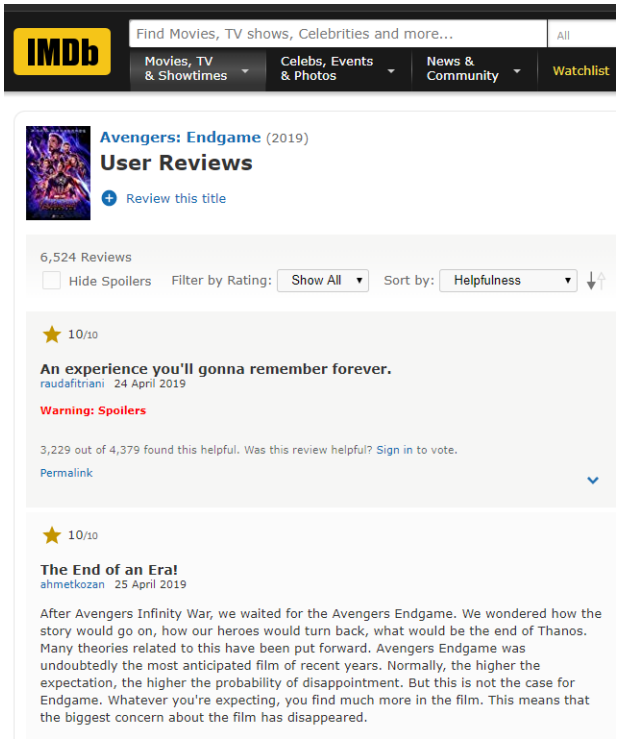
- data_helpers – 함수 추가

```
def load_real_imdb_data_and_labels(text_data_file, score_data_file):
    text_list = list(open(text_data_file, "r", encoding='utf-8').readlines())
    text_list = [s.strip() for s in text_list]
    score_list = list(open(score_data_file, "r", encoding='utf-8').readlines())
    score_list = [s.strip() for s in score_list]

    x_text = [clean_str(sent) for sent in text_list]
    print(score_list)
    y = []
    for score in score_list:
        if int(score) > 5:
            y.append([0, 1])
        else:
            y.append([1, 0])
    print(y)
    return [x_text, y]
```

CNN 분류기 평가 (실제 imdb data)

- Imdb_eval.py – 분류 결과 확인

```
predictions_human_readable = np.column_stack((np.array(x_raw), y_test,
all_predictions))
out_path = os.path.join(FLAGS.checkpoint_dir, "..", "prediction_imdb.csv")
```



an experience you 'll gonna remember forever there is no way that i could describe my emotions for this n	1	1
the end of an era ! after avengers infinity war , we waited for the avengers endgame we wondered how th	1	1
the ending made all 22 movies worth it if you 're going to watch this movie , avoid any spoilers , even spo	1	0
overall an epic conclusion but inferior to infinity war 's pace and energy ₩(spoiler free ₩) this is probably	1	1
amazing , but the more i dwell on it the worse it becomes i have to say , my first reaction walking out of t	1	1
the writers got carried away , the directors over reached and the studio sacrificed the integrity of their proc	0	1
overhyped infinity war was way better unpopular opinion let me start by saying that endgame is not a bac	1	0
dug themselves a hole they could n't get out of first of , infinity war was the greatest mcu movie ever mad	1	0
so much potential lost after infinity war i had huge expectations unfortunately i think it does n't follow th	1	0
absolute perfection end game ₩(score 10 10 ₩) absolute perfection end game ! ! good acting performanc	1	1
good but a mess in the story department a nice production for those only interested in action sequences b	0	0
emotional but bit messy so it all ends i have loved most of the mcu , some have been too predictable but	1	1
the best marvel superhero movie ever and also the epic conclusion to the 21 movies in the mcu avengers	1	1
all the epicness and efforts of 20 movies ruined with single snap are you moviegoer ₩? waited to long for	0	0
perfection unbelievable for marvel to pull this tour de force of a film is unreal 21 films 21 films culminatin	1	1

Q&A