https://github.com/kyliusmethod/KYLius-method

30분만에 개발하는 이미지 인식 프로그램

- **99.5%** 정확도 달성하기

KYLius

KYLius-method

https://github.com/kyliusmethod/KYLius-method

Team KYLius-method

Member: 김승혁, 곽상욱, 유수원, 이대곤

https://github.com/kyliusmethod/KYLius-method

We do:

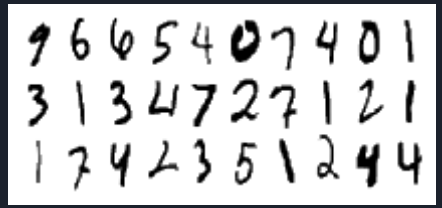
- Research Neural-Network
- Deep learning modeling
- Hyper-parameter tuning
- Online learning

https://github.com/kyliusmethod/KYLius-method

오늘 이야기할 내용들

1. Data set summary
2. Model
3. Handwriting
4. Ensemble
5. 결론

kaggle



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1. Data set

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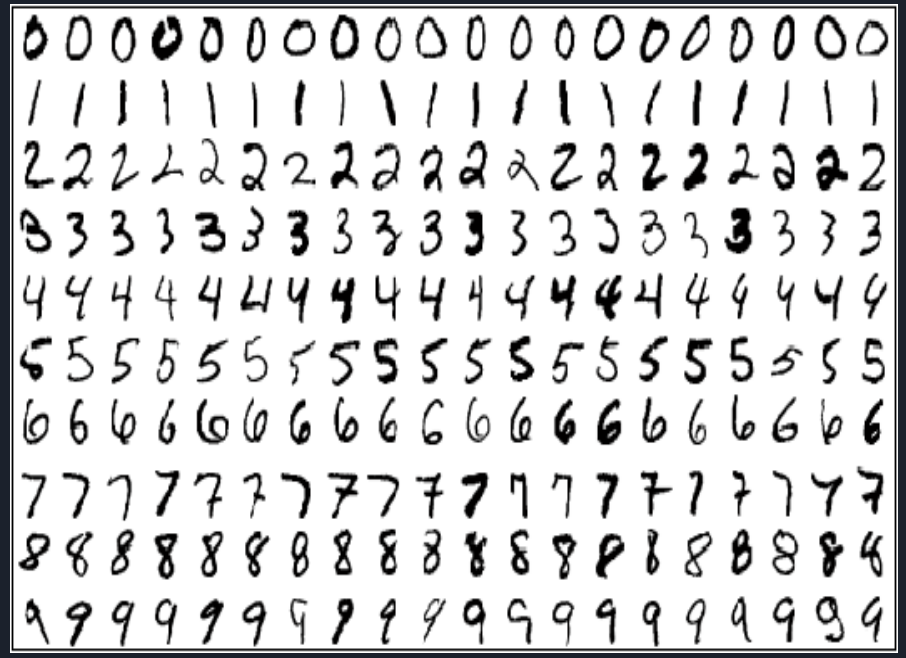
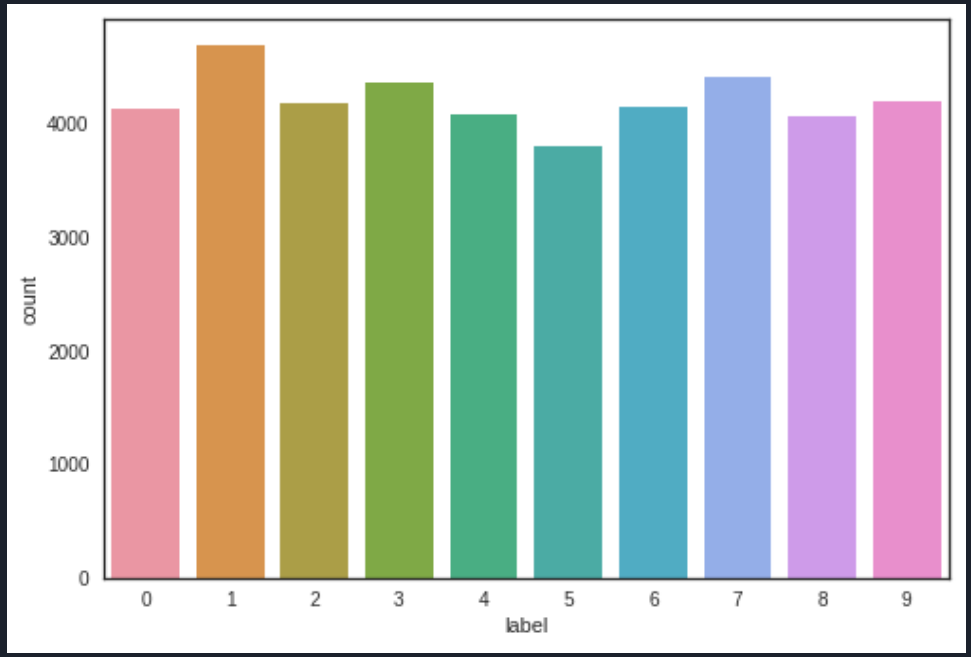
Kaggle MNIST Dataset





2. Model

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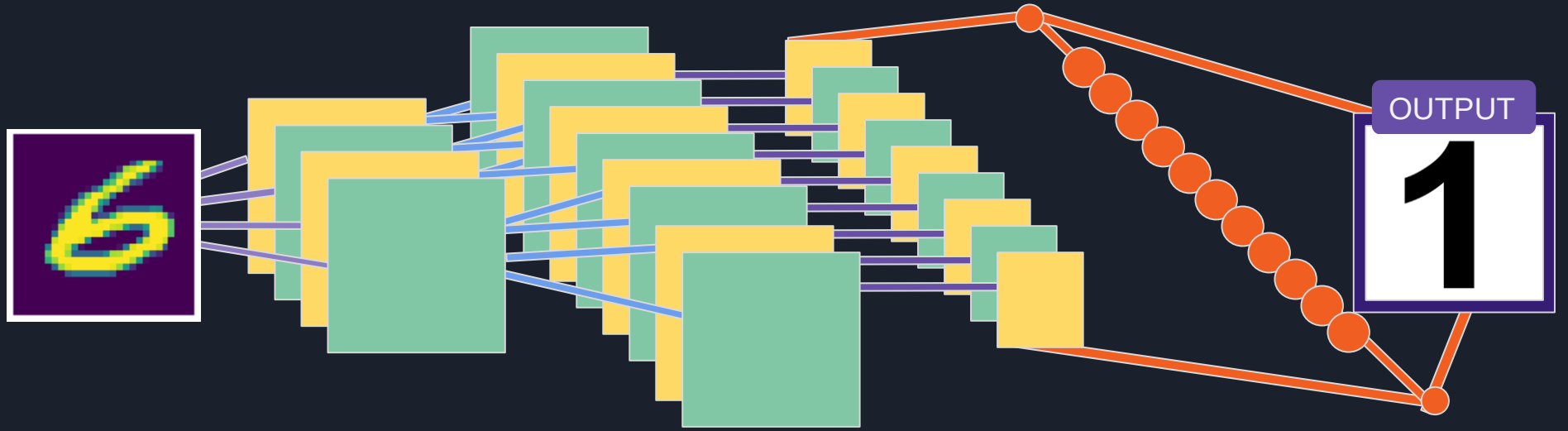
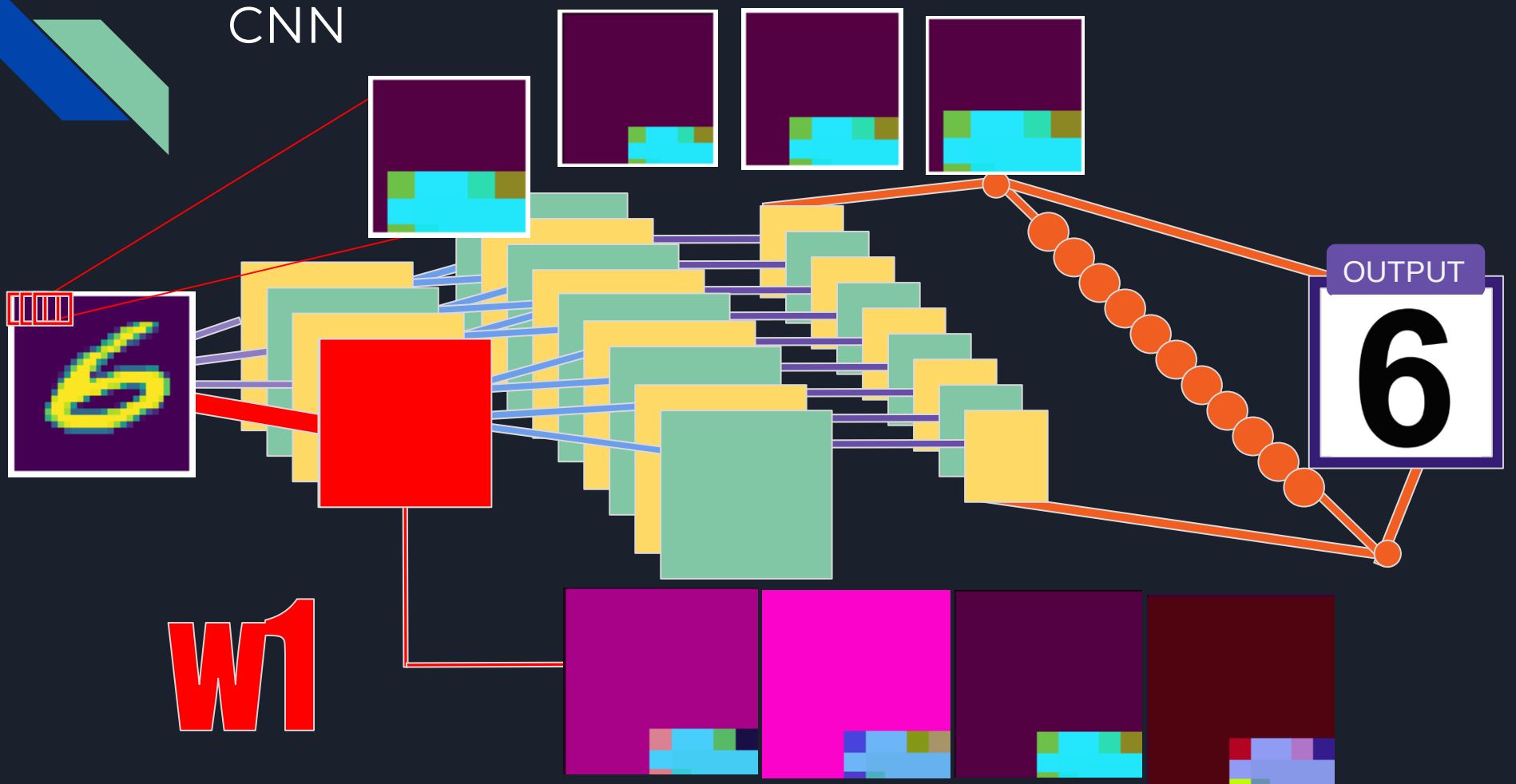
CNN



https://github.com/kyliusmethod/KYLius-method

CNN



https://github.com/kyliusmethod/KYLius-method

코

드

```
import tensorflow as tf
import numpy as np
tf.reset_default_graph()  #그래프 초기화
tf.set_random_seed(777)
import pandas as pd

#train = pd.read_csv('c:/python/train.csv')
train = pd.read_csv('C:/Users/Nak/train.csv')

#훈련세트, validation세트 나누기(문제은행에서 연습문제 나누기)
from sklearn.model_selection import train_test_split
train_set, validate_set = train_test_split(train, test_size = 0.3)
trainData = train_set.values[:,1:]
validateData = validate_set.values[:,1:]
trainLabel=train_set.values[:,0]
validateLabel=validate_set.values[:,0]

X = tf.placeholder(tf.float32, [None, 784])
X_img = tf.reshape(X, [-1, 28, 28, 1])       # img 28x28x1 (black/white)
Y = tf.placeholder(tf.int32, [None, 1])
Y_onehot=tf.reshape(tf.one_hot(Y, 10), [-1, 10])
p_keep_conv = tf.placeholder(tf.float32)
p_keep_hidden = tf.placeholder(tf.float32)

# hyper parameters(gpu로 밀어붙이는 learning_rate)
learning_rate = 0.00008
training_epochs = 300
batch_size = 100
steps_for_validate = 5
keep_prob = tf.placeholder(tf.float32)

# L1 ImgIn shape=(?, 28, 28, 1)
#W1 = tf.Variable(tf.random_normal([3, 3, 1, 32], stddev=0.01))
W1 = tf.get_variable("W1", shape=[3, 3, 1, 32],initializer=tf.contrib.layers.xavier_initializer())
L1 = tf.nn.conv2d(X_img, W1, strides=[1, 1, 1, 1], padding='SAME')
#L1 = tf.nn.relu(L1)
#L1 = tf.nn.elu(L1)
L1 = tf.nn.leaky_relu(L1,0.1)
L1 = tf.nn.max_pool(L1, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1], padding='SAME') # l1 shape=(?, 14, 14, 32)
L1 = tf.nn.dropout(L1, p_keep_conv)

# L2 ImgIn shape=(?, 14, 14, 10)
#W2 = tf.Variable(tf.random_normal([3, 3, 32, 64], stddev=0.01))
W2 = tf.get_variable("W2", shape=[3, 3, 32, 64],initializer=tf.contrib.layers.xavier_initializer())
L2 = tf.nn.conv2d(L1, W2, strides=[1, 1, 1, 1], padding='SAME')
#L2 = tf.nn.relu(L2)
#L2 = tf.nn.elu(L2)
L2 = tf.nn.leaky_relu(L2,0.1)
L2 = tf.nn.max_pool(L2, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1], padding='SAME') # l2 shape=(?, 7, 7, 64)
L2 = tf.nn.dropout(L2, p_keep_conv)

# L3 ImgIn shape=(?, 7, 7, 128)
#W3 = tf.Variable(tf.random_normal([3, 3, 64, 128], stddev=0.01))
W3 = tf.get_variable("W3", shape=[3, 3, 64, 128],initializer=tf.contrib.layers.xavier_initializer())
L3 = tf.nn.conv2d(L2, W3, strides=[1, 1, 1, 1], padding='SAME')
#L3 = tf.nn.relu(L3)
#L3 = tf.nn.elu(L3)
L3 = tf.nn.leaky_relu(L3,0.1)
L3 = tf.nn.max_pool(L3, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1], padding='SAME') # l3 shape=(?, 4, 4, 128)
L3 = tf.nn.dropout(L3, p_keep_conv)
L3_flat = tf.reshape(L3, shape=[-1, 128 * 4 * 4])  # reshape to (?, 2048)
# Final FC 4x4x128 inputs -> 10 outputs
#W4 = tf.Variable(tf.random_normal([128 * 4 * 4, 625], stddev=0.01))
W4 = tf.get_variable("W4", shape=[128 * 4 * 4, 625],initializer=tf.contrib.layers.xavier_initializer())
#L4 = tf.nn.relu(tf.matmul(L3_flat, W4))
#L4 = tf.nn.elu(tf.matmul(L3_flat, W4))
L4 = tf.nn.leaky_relu(tf.matmul(L3_flat, W4),0.1)
L4 = tf.nn.dropout(L4, p_keep_hidden)
W_o = tf.get_variable("W_o", shape=[625,10],initializer=tf.contrib.layers.xavier_initializer())
b = tf.Variable(tf.random_normal([10]))
logits = tf.matmul(L4, W_o) + b

# define cost/loss & optimizer
cost = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits(logits=logits,labels= Y_onehot))
#optimizer = tf.train.RMSPropOptimizer(0.001, 0.9).minimize(cost)
optimizer = tf.train.AdamOptimizer(learning_rate=learning_rate).minimize(cost) # 아담버전
predict_op = tf.argmax(logits, 1)

# initialize
sess = tf.Session()
sess.run(tf.global_variables_initializer())

# train my model
print('Learning started. It takes sometime.')
for epoch in range(training_epochs):
    avg_cost = 0
    total_batch = int(len(trainData) / batch_size)
    for i in range(total_batch):
        batch_xs = trainData[i*batch_size:(i+1)*batch_size]
        batch_ys = trainLabel[i*batch_size:(i+1)*batch_size].reshape(-1, 1)
        feed_dict = {X: batch_xs, Y: batch_ys, p_keep_conv: .7, p_keep_hidden: .5}
        c, _ = sess.run([cost, optimizer], feed_dict=feed_dict)
        avg_cost += c / total_batch
    print('Epoch:', '%04d' % (epoch + 1), 'cost =', '{:.9f}'.format(avg_cost))
    if epoch % steps_for_validate == steps_for_validate-1:
        correct_prediction = tf.equal(tf.argmax(logits, 1), tf.argmax(Y_onehot, 1))
        accuracy = tf.reduce_mean(tf.cast(correct_prediction, tf.float32))
        print('Accuracy:', sess.run(accuracy, feed_dict={
            X: validateData, Y: validateLabel.reshape(-1, 1), p_keep_conv: 1, p_keep_hidden: 1}))
print('Finished!')
```

https://github.com/kyliusmethod/KYLius-method

맨 위에서부터 차근차근

In [6]:

```
import tensorflow as tf
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p_keep_hidden = tf.placeholder(tf.float32)
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맨 위에서부터 차근차근

```python
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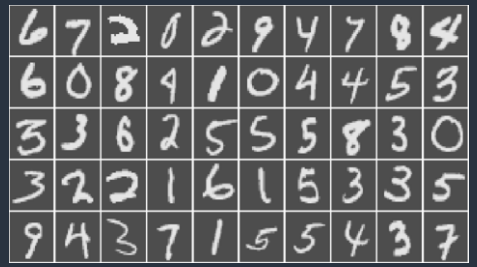
p_keep_conv = tf.placeholder(tf.float32)
p_keep_hidden = tf.placeholder(tf.float32)
```

train data = 연습문제(모의고사, 문제은행)
test data = 실전문제(수능, 기사시험)



https://github.com/kyliusmethod/KYLius-method

Hyper parameter

```
# hyper parameters(gpu로 밀어붙이는 learning_rate)
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training_epochs = 300
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steps_for_validate = 5
keep_prob = tf.placeholder(tf.float32)

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L1 = tf.nn.conv2d(X_img, W1, strides=[1, 1, 1, 1], padding='SAME')
```

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L1 = tf.nn.conv2d(X_img, W1, strides=[1, 1, 1, 1], padding='SAME')
```

https://github.com/kyliusmethod/KYLius-method

CNN

```
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L1 = tf.nn.conv2d(X_img, W1, strides=[1, 1, 1, 1], padding='SAME')
#L1 = tf.nn.relu(L1)
#L1 = tf.nn.elu(L1)
L1 = tf.nn.leaky_relu(L1,0.1)
L1 = tf.nn.max_pool(L1, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1], padding='SAME') # /1 shape=(?, 14, 14, 32)
L1 = tf.nn.dropout(L1, p_keep_conv)

# L2 ImgIn shape=(?, 14, 14, 10)
#W2 = tf.Variable(tf.random_normal([3, 3, 32, 64], stddev=0.01))
W2 = tf.get_variable("W2", shape=[3, 3, 32, 64],initializer=tf.contrib.layers.xavier_initializer())
L2 = tf.nn.conv2d(L1, W2, strides=[1, 1, 1, 1], padding='SAME')
```

https://github.com/kyliusmethod/KYLius-method

CNN(2단계 -> 3단계)

```
#L2 = tf.nn.relu(L2)
#L2 = tf.nn.elu(L2)
L2 = tf.nn.leaky_relu(L2,0.1)
L2 = tf.nn.max_pool(L2, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1], padding='SAME') # l2 shape=(?, 7, 7, 64)
L2 = tf.nn.dropout(L2, p_keep_conv)

# L3 ImgIn shape=(?, 7, 7, 128)
#W3 = tf.Variable(tf.random_normal([3, 3, 64, 128], stddev=0.01))
W3 = tf.get_variable("W3", shape=[3, 3, 64, 128],initializer=tf.contrib.layers.xavier_initializer())
L3 = tf.nn.conv2d(L2, W3, strides=[1, 1, 1, 1], padding='SAME')
```

https://github.com/kyliusmethod/KYLius-method

CNN(3단계->4단계:마지막 출력)

```
#L3 = tf.nn.relu(L3)
#L3 = tf.nn.elu(L3)
L3 = tf.nn.leaky_relu(L3,0.1)
L3 = tf.nn.max_pool(L3, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1], padding='SAME') # l3 shape=(?, 4, 4, 128)
L3 = tf.nn.dropout(L3, p_keep_conv)
L3_flat = tf.reshape(L3, shape=[-1, 128 * 4 * 4])    # reshape to (?, 2048)

# Final FC 4x4x128 inputs -> 10 outputs
#W4 = tf.Variable(tf.random_normal([128 * 4 * 4, 625], stddev=0.01))
W4 = tf.get_variable("W4", shape=[128 * 4 * 4, 625],initializer=tf.contrib.layers.xavier_initializer())
```

https://github.com/kyliusmethod/KYLius-method

CNN(4단계 출력)

```
#L4 = tf.nn.relu(tf.matmul(L3_flat, W4))
#L4 = tf.nn.elu(tf.matmul(L3_flat, W4))
L4 = tf.nn.leaky_relu(tf.matmul(L3_flat, W4),0.1)
L4 = tf.nn.dropout(L4, p_keep_hidden)
W_o = tf.get_variable("W_o", shape=[625,10],initializer=tf.contrib.layers.xavier_initializer())
b = tf.Variable(tf.random_normal([10]))
logits = tf.matmul(L4, W_o) + b

# define cost/loss & optimizer
cost  = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits(logits=logits,labels= Y_onehot))
```

https://github.com/kyliusmethod/KYLius-method

Optimizer?

```
#optimizer = tf.train.RMSPropOptimizer(0.001, 0.9).minimize(cost)
optimizer = tf.train.AdamOptimizer(learning_rate=learning_rate).minimize(cost) # 아담버전
predict_op = tf.argmax(logits, 1)

# initialize
sess = tf.Session()
sess.run(tf.global_variables_initializer())
```

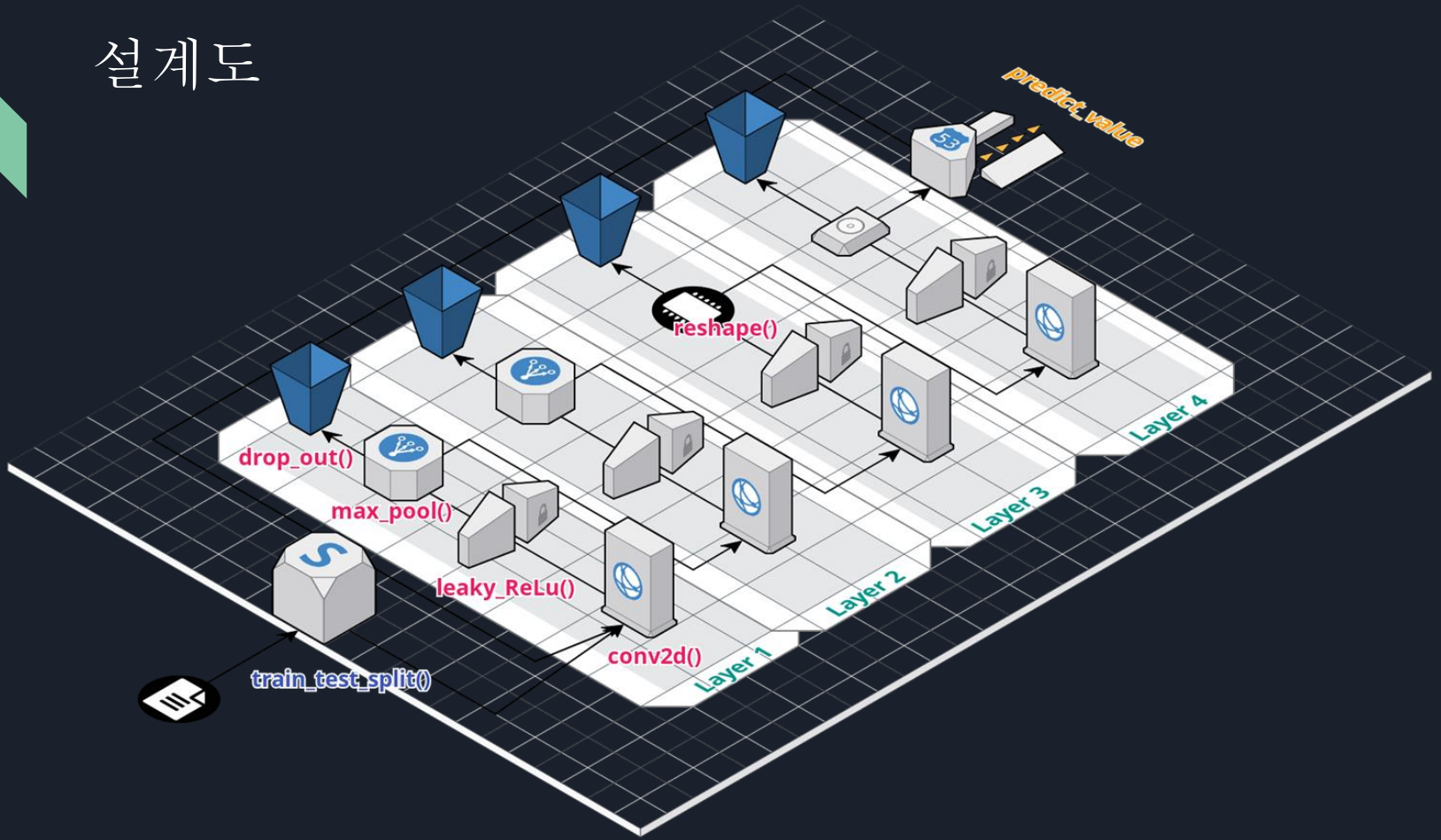
https://github.com/kyliusmethod/KYLius-method

돌려봅시다!

```python
# train my model
print('Learning started. It takes sometime.')
for epoch in range(training_epochs):
    avg_cost = 0
    total_batch = int(len(trainData) / batch_size)
    for i in range(total_batch):
        batch_xs = trainData[i*batch_size:(i+1)*batch_size]
        batch_ys = trainLabel[i*batch_size:(i+1)*batch_size].reshape(-1, 1)
        feed_dict = {X: batch_xs, Y: batch_ys, p_keep_conv: .7, p_keep_hidden: .5}
        c, _ = sess.run([cost, optimizer], feed_dict=feed_dict)
        avg_cost += c / total_batch
    print('Epoch:', '%04d' % (epoch + 1), 'cost =', '{:.9f}'.format(avg_cost))
    if epoch % steps_for_validate == steps_for_validate-1:
        correct_prediction = tf.equal(tf.argmax(logits, 1), tf.argmax(Y_onehot, 1))
        accuracy = tf.reduce_mean(tf.cast(correct_prediction, tf.float32))
        print('Accuracy:', sess.run(accuracy, feed_dict={
                X: validateData, Y: validateLabel.reshape(-1, 1), p_keep_conv: 1, p_keep_hidden: 1}))
print('Finished!')
```

https://github.com/kyliusmethod/KYLius-method

설계도



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3. HandWriting

KYLius

3. HandWriting
실제 손글씨를 얼마나 알아볼 수 있을까

https://github.com/kyliusmethod/KYLius-method

train_optimizer.py

1. 모델(trained model)의 학습결과를 저장

```
In [ ]:
# 변수 선언 후
sess = tf.Session()
sess.run(tf.global_variables_initializer())
saver = tf.train.Saver()
# 트레이닝 후
save_path = saver.save(sess,
"/Users/kimseunghyuck/desktop/git/daegon/KYLius-method/승혁/opt2/opt2")
```

3. HandWriting

실제 손글씨를 얼마나 알아볼 수 있을까?

https://github.com/leedaegon/KYLius-method

img_pred.py

class img_pred

2. 저장된 모델을 로드

```
# graph 의 메타 구조를 import
 saver=tf.train.import_meta_graph(opt_addr+".meta")
 sess = tf.InteractiveSession()
 print("Meta_Graph Imported")
 # 변수값들을 로드
 saver.restore(sess,
tf.train.get_checkpoint_state(opt_addr2).model_checkpoint_path)
 print("Parameters Restored")
```

3. HandWriting

실제 손글씨를 얼마나 알아볼 수 있을까?

https://github.com/kyliusmethod/KYLius-method

img_pred.py

class img_pred

2. 저장된 모델을 로드

```
# 변수들을 호출 가능한 형태로 만듬
graph=tf.get_default_graph()
X=graph.get_tensor_by_name('X:0')
pred=graph.get_tensor_by_name('pred:0')
p_keep_conv=graph.get_tensor_by_name('p_keep_conv:0')
p_keep_hidden=graph.get_tensor_by_name('p_keep_hidden:0')
print("Variables Saved")
```

3. HandWriting

실제 손글씨를 얼마나 알아볼 수 있을까?

https://github.com/kyliusmethod/KYLius-method

img_pred.py

class img_pred

function number

3. 손글씨 이미지를 csv 형태로 변환

```
import matplotlib.pyplot as plt
 from PIL import Image
 im=Image.open(arg1)
 img = np.array(im.resize((28, 28), Image.ANTIALIAS).convert("L"))
 data = img.reshape([1, 784])
 data = 255 - data
```

3. HandWriting
실제 손글씨를 얼마나 알아볼 수 있을까?

https://github.com/kyliusmethod/KYLius-method

img_pred.py

class img_pred

function number

4. csv 데이터로 결과 출력

```
sess.run(pred, feed_dict={X: data,
p_keep_conv: 1.0, p_keep_hidden: 1.0})
```

잘 나오는지 한번 볼까요? (시연)

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4. Ensemble

KYLius

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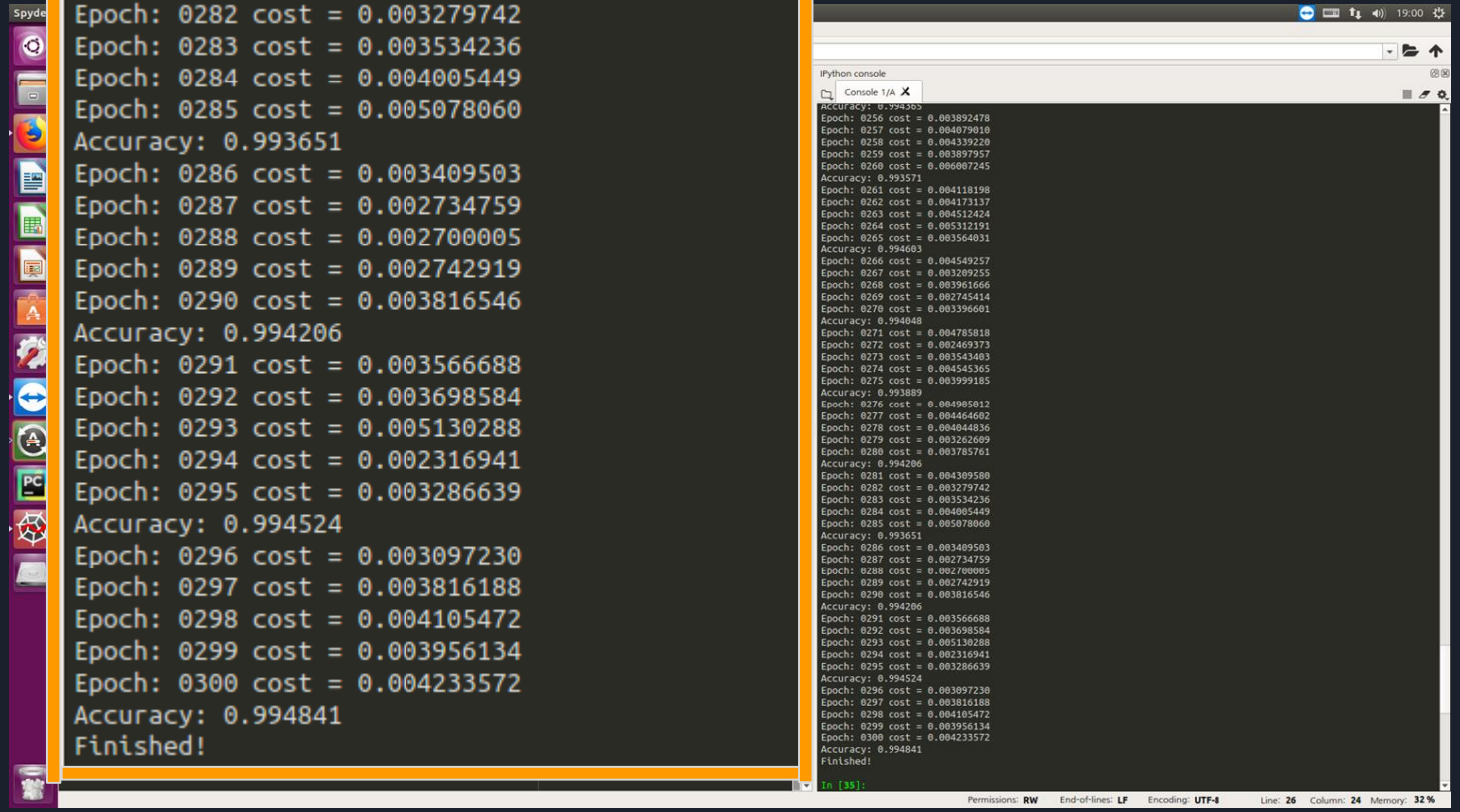
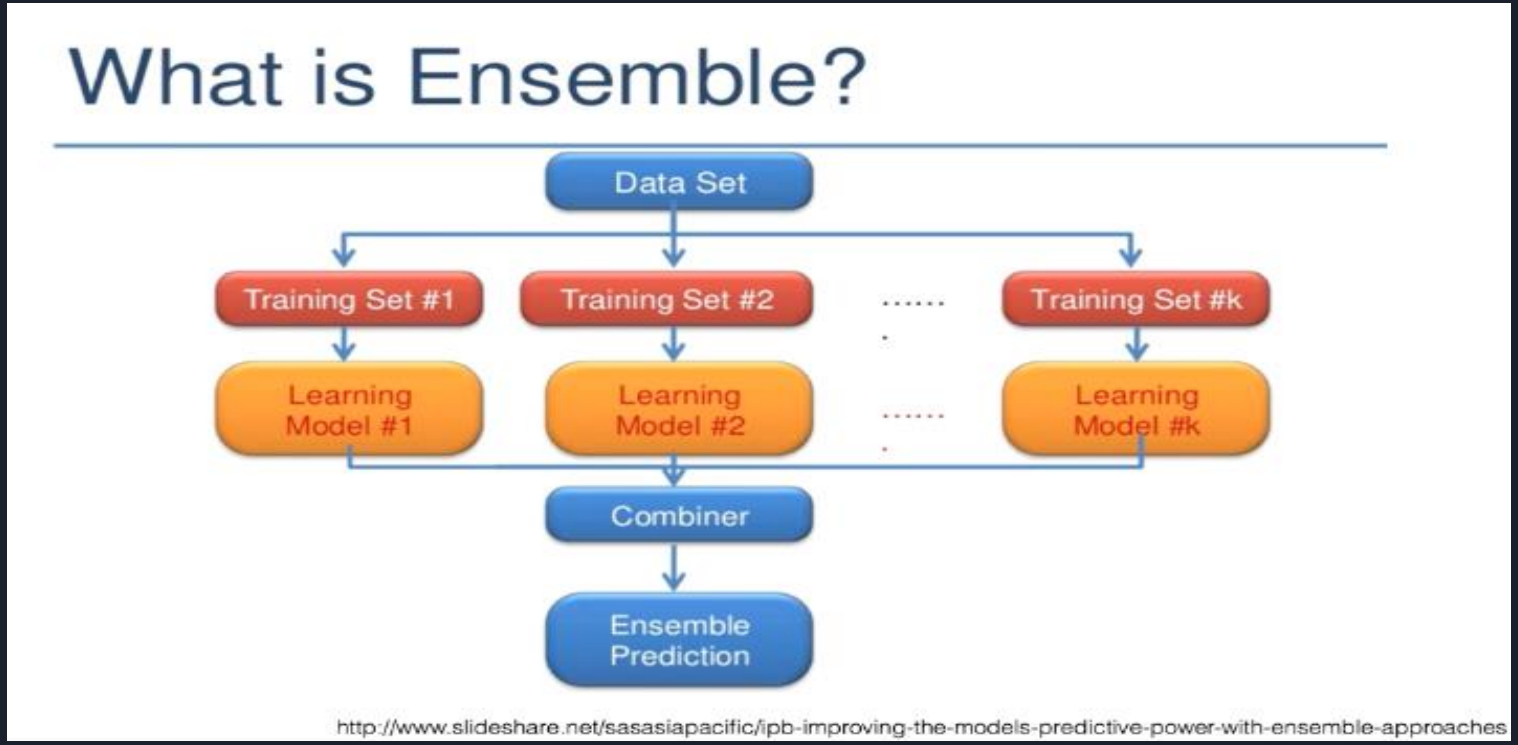
부록 - Ensemble

```
Epoch: 0281 cost = 0.004309580
Epoch: 0282 cost = 0.003279742
Epoch: 0283 cost = 0.003534236
Epoch: 0284 cost = 0.004005449
Epoch: 0285 cost = 0.005078060
Accuracy: 0.993651
Epoch: 0286 cost = 0.003409503
Epoch: 0287 cost = 0.002734759
Epoch: 0288 cost = 0.002700005
Epoch: 0289 cost = 0.002742919
Epoch: 0290 cost = 0.003816546
Accuracy: 0.994206
Epoch: 0291 cost = 0.003566688
Epoch: 0292 cost = 0.003698584
Epoch: 0293 cost = 0.005130288
Epoch: 0294 cost = 0.002316941
Epoch: 0295 cost = 0.003286639
Accuracy: 0.994524
Epoch: 0296 cost = 0.003097230
Epoch: 0297 cost = 0.003816188
Epoch: 0298 cost = 0.004105472
Epoch: 0299 cost = 0.003956134
Epoch: 0300 cost = 0.004233572
Accuracy: 0.994841
Finished!
```



https://github.com/kyliusmethod/KYLius-method

부록 - **Ensemble**



https://github.com/kyliusmethod/KYLius-method

부록 - **Ensemble**

이전 코드

```
# L1 ImgIn shape=(?, 28, 28, 1)
W1 = tf.get_variable("W1", shape=[3, 3, 1,
32],initializer=tf.contrib.layers.xavier_initializer())
L1 = tf.nn.conv2d(X_img, W1, strides=[1, 1, 1, 1], padding='SAME')
#L1 = tf.nn.relu(L1)
L1 = tf.nn.leaky_relu(L1,0.1)
L1 = tf.nn.max_pool(L1, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1],
padding='SAME') # l1 shape=(?, 14, 14, 32)
L1 = tf.nn.dropout(L1, p_keep_conv)

# L2 ImgIn shape=(?, 14, 14, 10)
W2 = tf.get_variable("W2", shape=[3, 3, 32,
64],initializer=tf.contrib.layers.xavier_initializer())
L2 = tf.nn.conv2d(L1, W2, strides=[1, 1, 1, 1], padding='SAME')
#L1 = tf.nn.relu(L1)
L2 = tf.nn.leaky_relu(L2,0.1)
L2 = tf.nn.max_pool(L2, ksize=[1, 2, 2, 1],strides=[1, 2, 2, 1],
padding='SAME') # l2 shape=(?, 7, 7, 64)
                ...
                ...
                ...
```

Class code

```
class Model:

  def __init__(self, sess, name):
     self.sess = sess
     self.name = name
     self._build_net()

  def _build_net(self): //여기에 모든 레이어를 넣습니다.

     with tf.variable_scope(self.name):
          self.X = tf.placeholder(tf.float32, [None, 784])
          X_img = tf.reshape(self.X, [-1, 28, 28, 1])
          self.Y = tf.placeholder(tf.float32, [None, 10])

         # L1 ImgIn shape=(?, 28, 28, 1)
         W1 = tf.Variable(tf.random_normal([3, 3, 1, 32], stddev=0.01))
         ...

   def predict(self, x_test, keep_prop=1.0):
       return self.sess.run(self.logits,
       feed_dict={self.X: x_test, self.keep_prob: keep_prop})
```

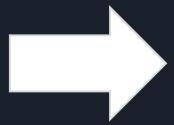
https://github.com/kyliusmethod/KYLius-method

부록 - **Ensemble**

이전 코드 코스트 출력

```
Epoch:  0001 Cost =  8.49241807
Epoch:  0002 Cost =  2.00249927
Epoch:  0003 Cost =  1.05088007
Epoch:  0004 Cost =  0.66475868
Epoch:  0005 Cost =  0.59724291
Epoch:  0006 Cost =  0.49182685
Epoch:  0007 Cost =  0.37189295
Epoch:  0008 Cost =  0.36213403
Epoch:  0009 Cost =  0.27789087
Epoch:  0010 Cost =  0.29027444
Accuracy: 0.9341

Epoch:  0011 Cost =  0.31032155
Epoch:  0012 Cost =  0.27787288
Epoch:  0013 Cost =  0.20681616
Epoch:  0014 Cost =  0.1766747
Epoch:  0015 Cost =  0.18023166
Epoch:  0016 Cost =  0.16275373
Epoch:  0017 Cost =  0.1439912
Epoch:  0018 Cost =  0.16074292
Epoch:  0019 Cost =  0.129944
Epoch:  0020 Cost =  0.11760519
```



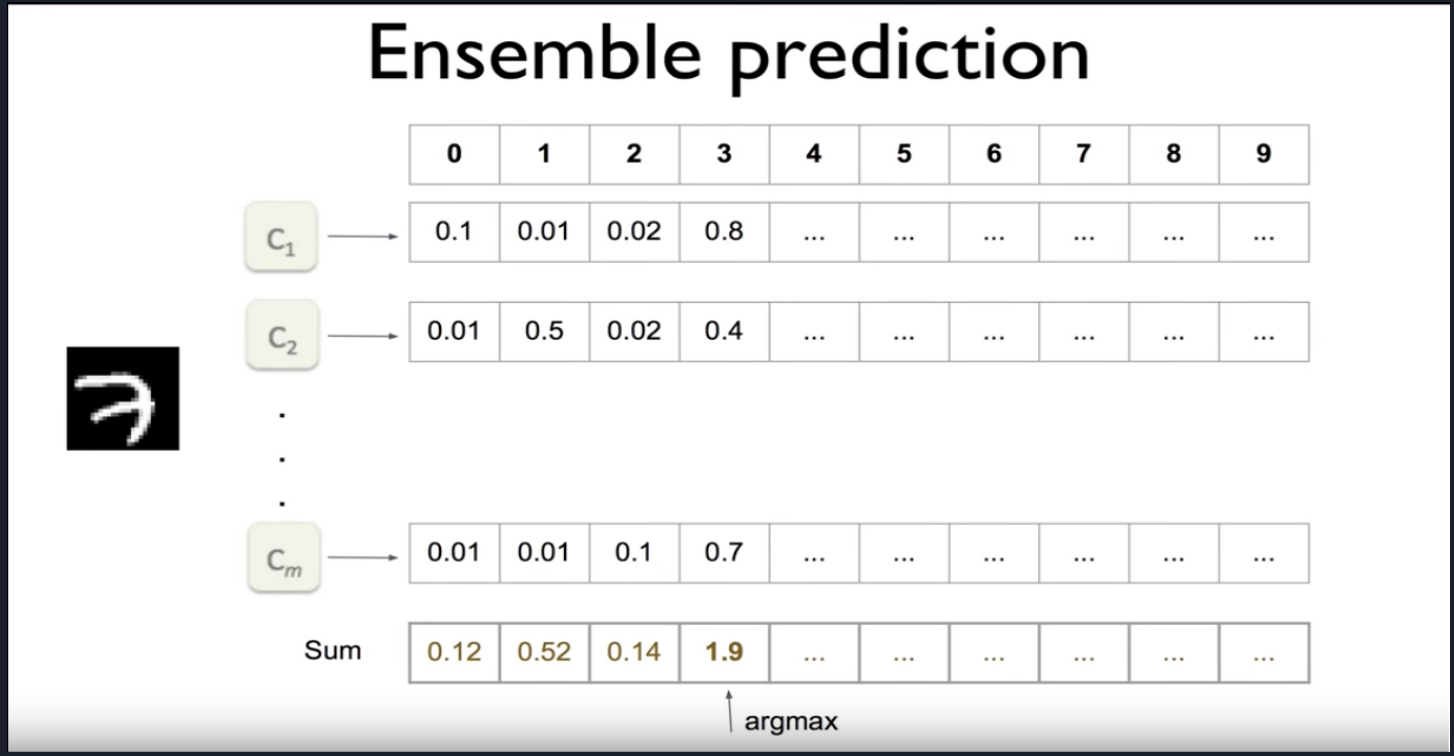
emsemble 코스트 출력
모델 5개

```
Epoch:  0001 Cost =  [ 8.49241807  10.87485297  10.52818911   7.12766369   7.58521522]
Epoch:  0002 Cost =  [ 1.66913546  2.0372428   2.00249927  1.47342024  1.64121001]
Epoch:  0003 Cost =  [ 1.05441222  1.29278263  1.25971556  0.9297188   1.05088007]
Epoch:  0004 Cost =  [ 0.77209901  0.96274401  0.89902738  0.66475868  0.77866484]
Epoch:  0005 Cost =  [ 0.59724291  0.75306771  0.70474437  0.53224141  0.58912528]
Epoch:  0006 Cost =  [ 0.49759393  0.6228686   0.5576628   0.43235828  0.49182685]
Epoch:  0007 Cost =  [ 0.42757112  0.52155101  0.46283212  0.37189295  0.41670503]
Epoch:  0008 Cost =  [ 0.36458481  0.45986743  0.40814632  0.32401     0.36213403]
Epoch:  0009 Cost =  [ 0.32700458  0.38760419  0.35965106  0.27789087  0.31364639]
Epoch:  0010 Cost =  [ 0.29027444  0.3512799   0.31902656  0.2587427   0.27308713]
Accuracy: [ 0.93215 0.924485 0.941115 0.9315481 0.945112]

Epoch:  0011 Cost =  [ 0.25922384  0.31032155  0.28886831  0.23514648  0.26196254]
Epoch:  0012 Cost =  [ 0.23628862  0.27787288  0.26135749  0.20697285  0.22838042]
Epoch:  0013 Cost =  [ 0.21110017  0.25410617  0.23468112  0.18942689  0.20681616]
Epoch:  0014 Cost =  [ 0.19857974  0.22948367  0.21368499  0.1766747   0.19431507]
Epoch:  0015 Cost =  [ 0.18023166  0.21097862  0.20243013  0.1701023   0.17910747]
Epoch:  0016 Cost =  [ 0.16610203  0.19096776  0.1876079   0.15377879  0.16275373]
Epoch:  0017 Cost =  [ 0.15477573  0.18003848  0.16935547  0.1439912   0.15484631]
Epoch:  0018 Cost =  [ 0.1430705   0.16939201  0.16074292  0.13027417  0.14399578]
Epoch:  0019 Cost =  [ 0.1379196   0.15855069  0.15091801  0.1279273   0.129944  ]
Epoch:  0020 Cost =  [ 0.12886279  0.14519003  0.13762941  0.11760519  0.12391298]
```

https://github.com/kyliusmethod/KYLius-method

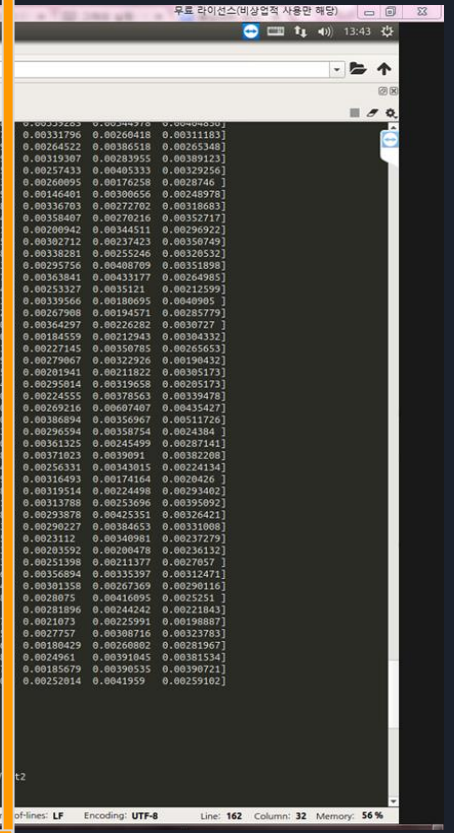
부록 - **Ensemble**



https://github.com/kyliusmethod/KYLius-method

부록 - Ensemble

```
Epoch:  0375 Cost =  [ 0.00337258  0.00291041  0.00295014  0.00319658  0.00205173]
Epoch:  0376 Cost =  [ 0.00225759  0.00334605  0.00224555  0.00378563  0.00339478]
Epoch:  0377 Cost =  [ 0.00245181  0.00256908  0.00269216  0.00607407  0.00435427]
Epoch:  0378 Cost =  [ 0.00268352  0.00258506  0.00386894  0.00356967  0.00511726]
Epoch:  0379 Cost =  [ 0.0032349   0.00357136  0.00296594  0.00358754  0.0024384 ]
Epoch:  0380 Cost =  [ 0.00264649  0.00341906  0.00361325  0.00245499  0.00287141]
Epoch:  0381 Cost =  [ 0.00202985  0.00264583  0.00371023  0.0039091   0.00382208]
Epoch:  0382 Cost =  [ 0.00460582  0.00275744  0.00256331  0.00343015  0.00224134]
Epoch:  0383 Cost =  [ 0.00268927  0.00252092  0.00316493  0.00174164  0.0020426 ]
Epoch:  0384 Cost =  [ 0.00217946  0.00187081  0.00319514  0.00224498  0.00293402]
Epoch:  0385 Cost =  [ 0.00331092  0.00194117  0.00313788  0.00253696  0.00395092]
Epoch:  0386 Cost =  [ 0.00235657  0.00280586  0.00293878  0.00425351  0.00326421]
Epoch:  0387 Cost =  [ 0.00228023  0.00277434  0.00290227  0.00384653  0.00331008]
Epoch:  0388 Cost =  [ 0.00136978  0.00184256  0.0023112   0.00340981  0.00237279]
Epoch:  0389 Cost =  [ 0.00249313  0.00380039  0.00203592  0.00200478  0.00236132]
Epoch:  0390 Cost =  [ 0.00382729  0.00223138  0.00251398  0.00211377  0.0027057 ]
Epoch:  0391 Cost =  [ 0.00238345  0.00315367  0.00356894  0.00335397  0.00312471]
Epoch:  0392 Cost =  [ 0.00259086  0.00359748  0.00301358  0.00267369  0.00290116]
Epoch:  0393 Cost =  [ 0.00316236  0.00390281  0.0028075   0.00416095  0.0025251 ]
Epoch:  0394 Cost =  [ 0.00355389  0.003331    0.00281896  0.00244242  0.00221843]
Epoch:  0395 Cost =  [ 0.00353289  0.00343076  0.0021073   0.00225991  0.00198887]
Epoch:  0396 Cost =  [ 0.00282651  0.0030055   0.0027757   0.00308716  0.00323783]
Epoch:  0397 Cost =  [ 0.002623    0.00305262  0.00180429  0.00260802  0.00281967]
Epoch:  0398 Cost =  [ 0.00245636  0.00267282  0.0024961   0.00391045  0.00381534]
Epoch:  0399 Cost =  [ 0.00225432  0.00339072  0.00185679  0.00390535  0.00390721]
Epoch:  0400 Cost =  [ 0.00162053  0.00268204  0.00252014  0.0041959   0.00259102]
Training Finished
0 Accuracy:  0.994048
1 Accuracy:  0.993571
2 Accuracy:  0.993889
3 Accuracy:  0.994524
4 Accuracy:  0.994365
Ensemble accuracy: 0.995079
Model saved to /home/itwill03/다운로드/opt2/opt2
```



https://github.com/kyliusmethod/KYLius-method

감사합니다

https://github.com/suwonyu

KYLius