Deep Learning Based Recommendation (Part B)

Topic 9B

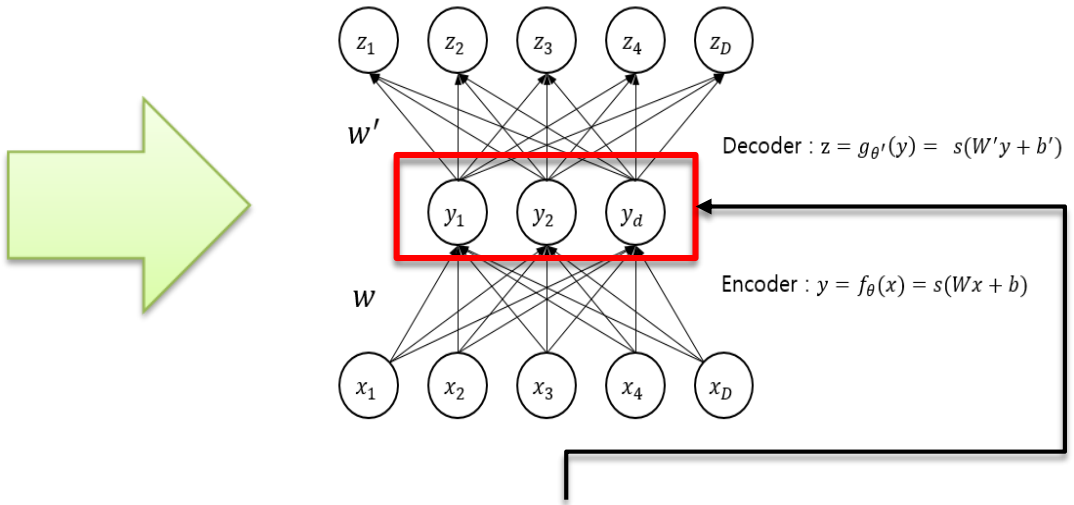
Deep learning

- Autoencoder for recommender system
  - Autoencoder example in Keras
  - Alternative DL Framework
  - Google Colab
  - Running an example in Google Colab

Autoencoder for recommender system

	Item 1	Item 2	Item 3	Item 4	Item 5
User 1	0	3	0	3	0
User 2	4	0	0	2	0
User 3	0	0	3	0	0
User 4	3	0	4	0	3
User 5	4	3	0	4	0

A matrix of user/item ratings



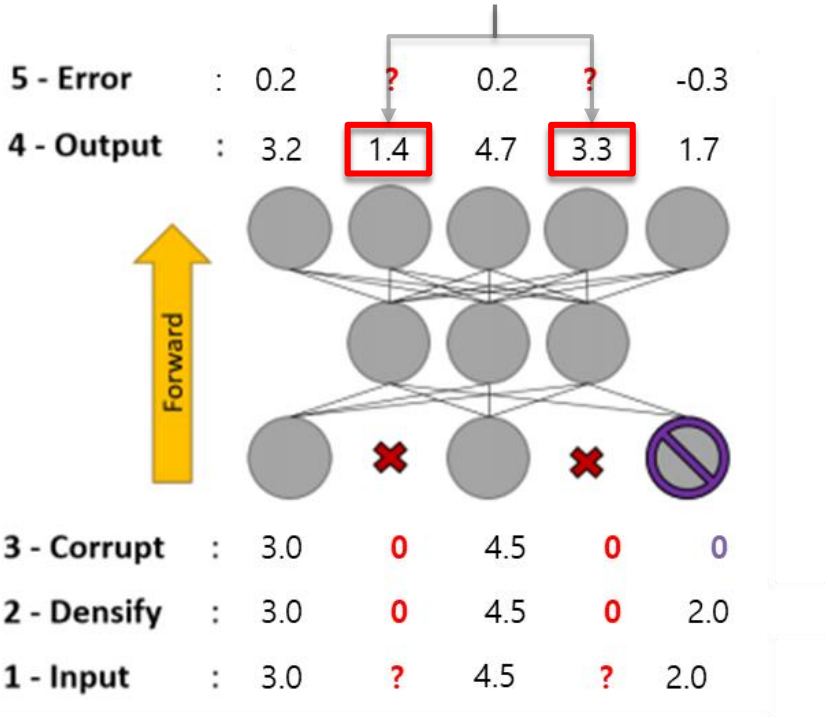
In global context, the latent representation in encoding layer can be expected to embrace users' preferences for items, or vice versa.

Autoencoder for recommender system

	i_1	i_2	i_3	i_4	i_5
u_1		4.5	2.0		
u_2	4.0		3.5		
u_3	3.0		4.5		2.0
u_4		3.5	4.0		1.0

Rating Matrix(R)

These can be considered as prediction



$$argmin_{\{W_l\}\{b_l\}} = ||\tilde{X} - \hat{X}||_F^2 + \lambda \sum_l^L (||W_l||_F^2 + ||b_l||_F^2)$$

Training error on observed ratings

Regularization to avoid overfitting

Autoencoder example in Keras

Autoencoder for MNIST (Hand written images)

```
## Build Autoencoder model
# this is our input placeholder
input_img = Input(shape=(784,))

# "encoded" is the encoded representation of the input
encoded = Dense(32,
                activation='relu')(input_img)

# "decoded" is the lossy reconstruction of the input
decoded = Dense(784,
                activation='sigmoid')(encoded)

# this model maps an input to its reconstruction
autoencoder = Model(input_img, decoded)

## Show model Information
autoencoder.summary()

o_RMSprop = optimizers.RMSprop(lr=0.001,
                               rho=0.9,
                               epsilon=None,
                               decay=0.0)

## Set train methodology
autoencoder.compile(loss='binary_crossentropy',
                    optimizer=o_RMSprop)
```

① Input dimension (flattened image dimension)

② The number of hidden layer's neuron

③ Activation function in encoder

④ Output dimension (flattened image dimension)

⑤ Activation function in decoder

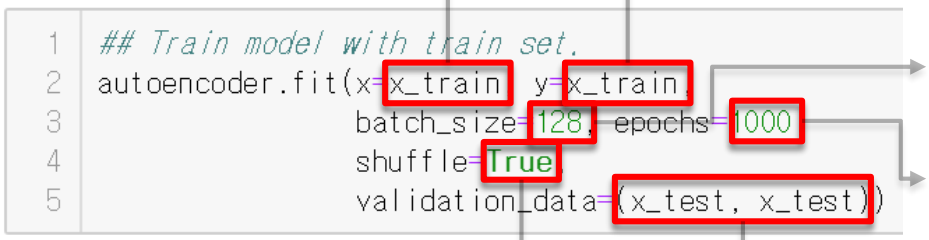
⑥ Optimizer

⑦ Learning rate

⑧ Loss function (objective function)

Autoencoder example in Keras

Autoencoder for MNIST (Hand written images)



```
## Train model with train set.
autoencoder.fit(x=x_train, y=x_train,
                batch_size=128, epochs=1000,
                shuffle=True,
                validation_data=(x_test, x_test))
```

① x: Input set (flattened image dimension)

② y: Output set (flattened image dimension)

※ **This is same with x (input set)**

③ batch_size: the number of data in input subset

④ epochs: the number of iterations

⑤ shuffle:
shuffling of input set for model's robustness

⑥ validation_data:
Validation set for hyperparamter or
early stopping, etc.

Autoencoder example in Keras

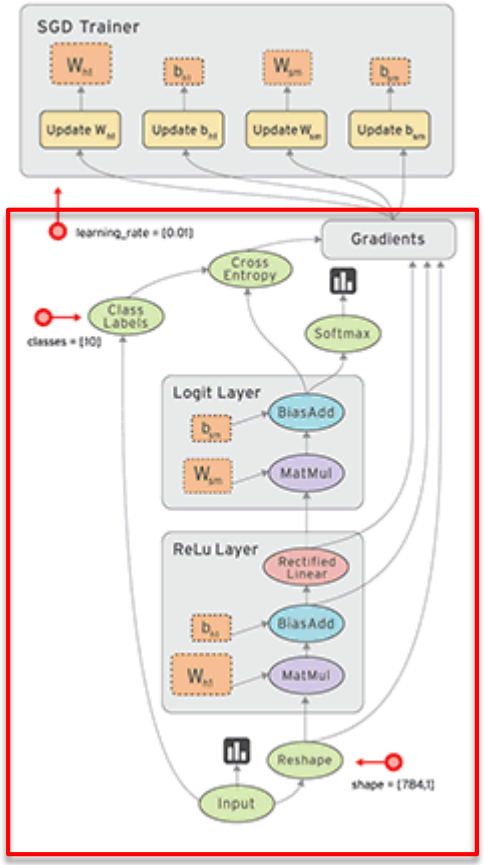
- Techniques for boosting performance of Autoencoder
  - Change dimension of input, output, and hidden
  - Change loss function
  - Change optimizer function (RMSprop, Adagrad, Adam, and etc)
  - Add more layers in encoder and decoder **(Stacked autoencoder)**
  - Try different activation function (ReLU, Sigmoid, Tanh, Softmax, etc)
  - Add noise to input set **(Denoising autoencoder)**
  - Add regularization term for loss **(Sparse autoencoder)**

Practice

- Deep Learning Framework
  - Tensorflow
  - Keras
  - PyTorch
- Google Colaboratory (Colab)
- Running an example using Google Colab

TensorFlow

- Open source platform for numerical computation by Google
  - Using data flow graphs
- Data flow graphs (DFG)
  - Each node in the **graph** represents the instance of a mathematical operation (multiply, add, divide, …).
  - Each edge is a multi-dimensional **data** set (tensors) on which the operations are performed.



Data flow graphs

PyTorch

- Open source platform for numerical computation by Facebook
  - Tensor computation with strong GPU acceleration.
  - Deep learning built on a tape-based autodiff system.
  - Can change DFG at runtime unlike TensorFlow
- Difference between PyTorch vs TensorFlow

For example, to calculate 1 + ½ + ¼ + ⅛ + ... ,

PyTorch

```
import torch

x = torch.Tensor([0.])
y = torch.Tensor([1.])

for iteration in range(50):
    x = x + y
    y = y / 2

print(x)
```

TensorFlow

Construction Phase

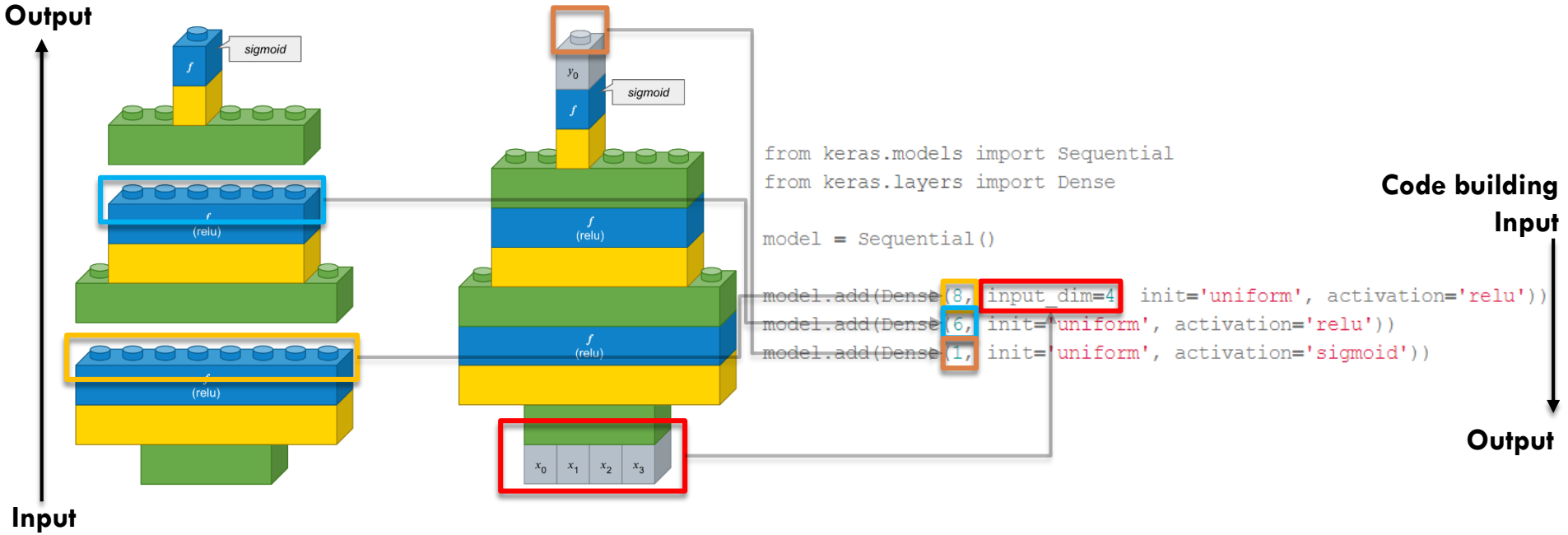
```
import tensorflow as tf

x = tf.Variable(0.)
y = tf.Variable(1.)
add_op = x.assign(x + y)
div_op = y.assign(y / 2)
init = tf.global_variables_initializer()
```

Execution Phase

```
with tf.Session() as sess:
    init.run()
    for iteration in range(50):
        sess.run(add_op)
        sess.run(div_op)
    print(x.eval())
```

Keras

- A high-level neural networks API
  - Running on top of TensorFlow, CNTK, Theano.
  - Allowing for easy and fast prototyping (through user friendliness, modularity, and extensibility).

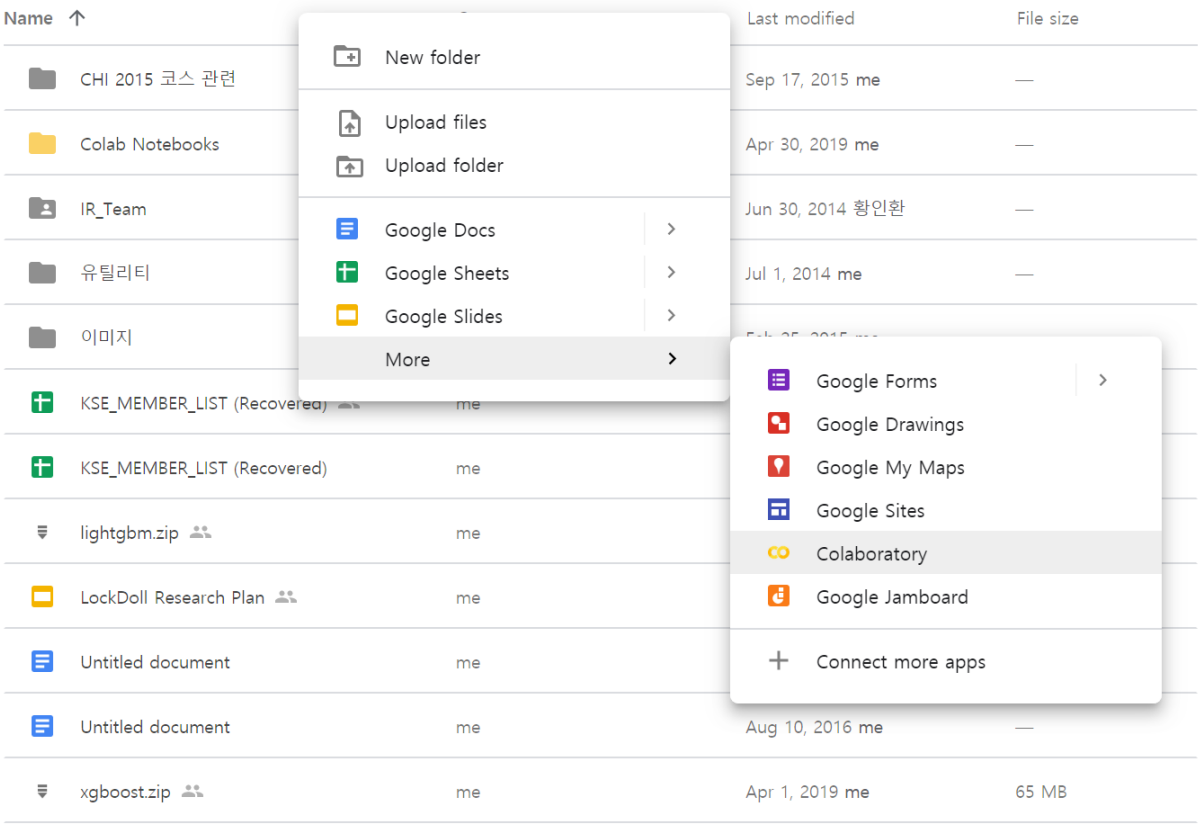


Conceptual model diagram with Lego vs Actual Implementation

Google Colaboratory (Colab)

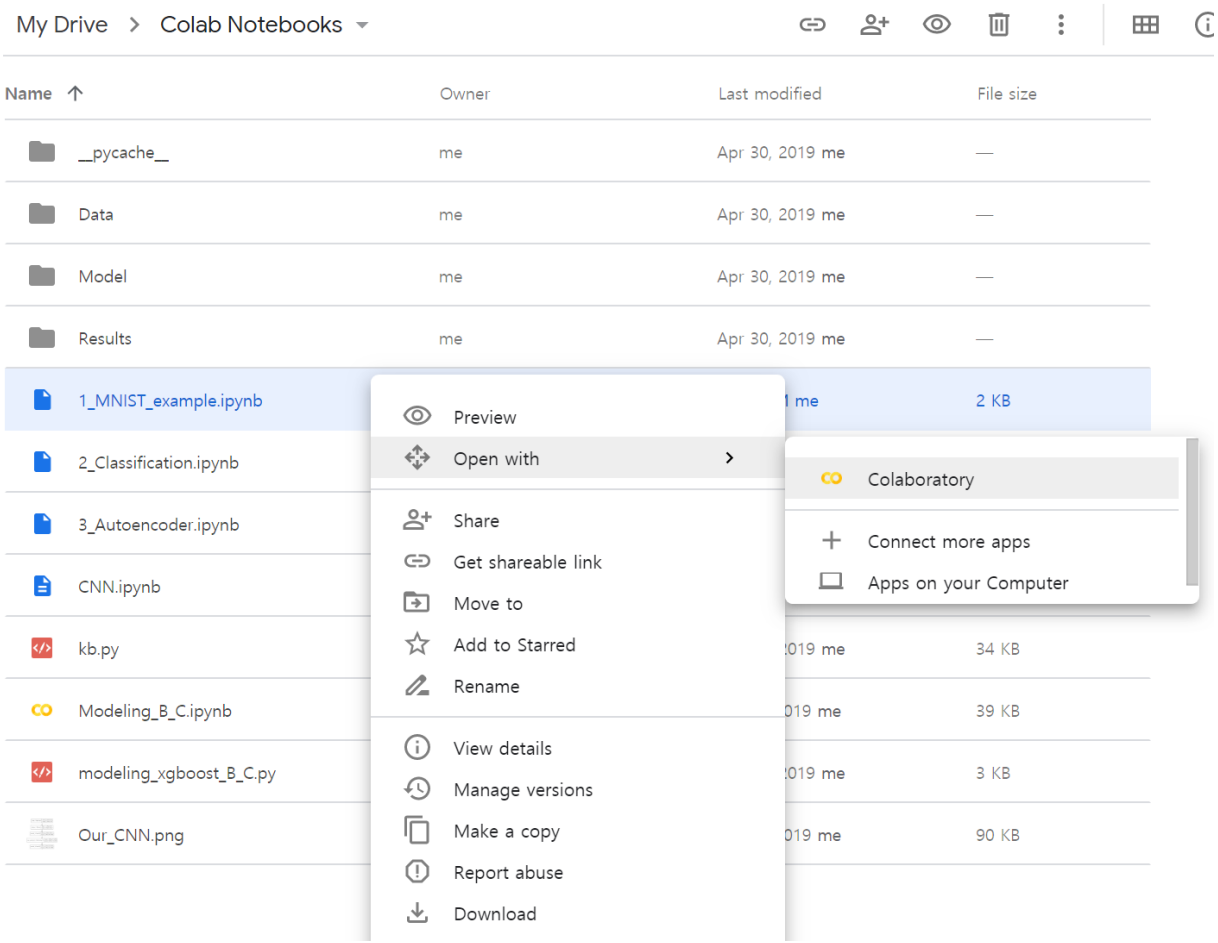
- Free service provided by Google for academy (https://colab.research.google.com/notebooks/welcome.ipynb)
  - Jupyter Notebook + Google Drive
    - It requires Gmail account and you can connect personal Google drive to save results and models.
    - It is also available Linux commend to handle environment.
  - Computer Specifications
    - OS: Ubuntu 18.04
    - CPU: Xenon 2.3GHz
    - GPU: Tesla K80
    - Memory: 13G
  - Available for up to 12 hours, and after 12 hours initializing all environment settings and files.

Example – First starts



Getting Started with Google Colab:
https://towardsdatascience.com/getting-started-with-google-colab-f2fff97f594c

Example – First starts



Or, upload provided ipynb file, and open with Colaboratory

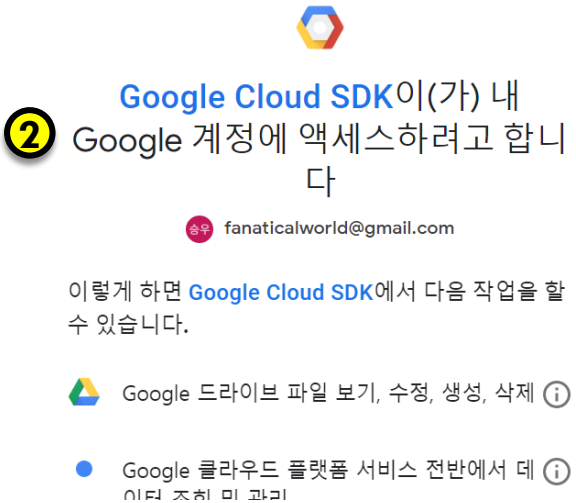
Example – Sync Google drive

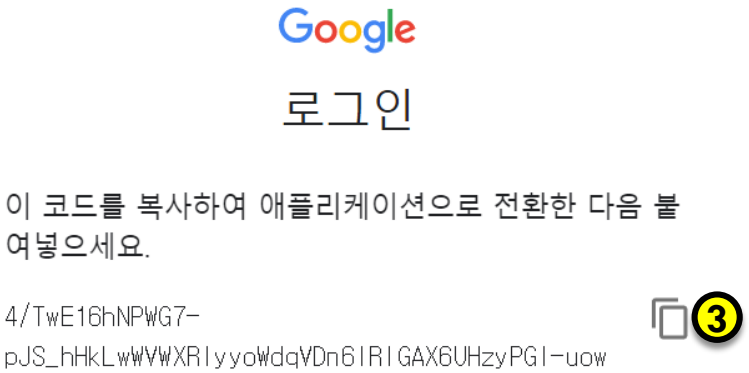
Sync your Google Drive

```
from google.colab import auth
auth.authenticate_user()

from google.colab import drive
drive.mount('/content/gdrive')
```

```
Go to the following link in your browser:
https://accounts.google.com/o/oauth2/auth?redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%3Aoob&prompt=select_account&response_type=code&client_id=32555940559.apps
Enter verification code:
```

① ④





Then, sync your google drive to save results and models

Example – Sync Google drive

Mount Google drive's root and drive folder

```
[18]  cd /content/gdrive/My Drive
```

```
/content/gdrive/My Drive
```

```
[20]  ls -ltr
```

```
total 133480
drwx------ 2 root root     4096 Jun 30  2014  IR_Team/
drwx------ 2 root root     4096 Jul  1  2014  유틸리티/
drwx------ 2 root root     4096 Feb 25  2015  이미지/
drwx------ 2 root root     4096 Sep 17  2015 'CHI 2015 코스 관련'/
-rw------- 1 root root 68912717 Mar 31 19:43  lightgbm.zip
-rw------- 1 root root 67745435 Mar 31 19:43  xgboost.zip
drwx------ 3 root root     4096 Apr 30 10:38 'Colab Notebooks'/
drwx------ 2 root root     4096 May 19 15:10  문서/
```

Select your own folder and Go into a folder

```
[21]  cd Colab Notebooks
```

```
/content/gdrive/My Drive/Colab Notebooks
```

Example – GPU Acceleration