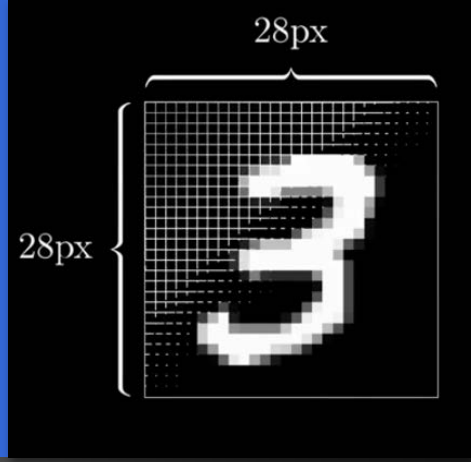
Deep Learning

for Image Classification and Segmentation

The study plan

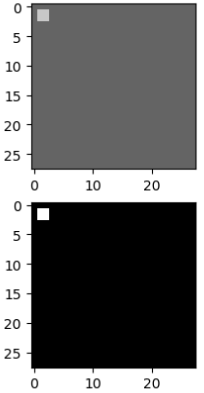
- Unit 2: What is image classification and how to implement a solution?

What is image classification?



- A gray image whose size is nxm has nxm pixels
- The gray level of each pixel is between 0 to 255 or 0 to 1 (normalized, double format)
- How to convert a double matrix image to a unit8 matrix?
- How to convert a matrix to a Gray scale image?
- Input an image and output a class label

What is image?



- Learning Python from comparing Matlab with Python

How to implement a solution?

- Using training images to train a Classifier
- Using testing images to evaluation the a Classifier
- Input an image and output a class label

Major Course Assignments

Individual Assignment Activity of Unit 3:
Run the Lab: Image Classification with DIGITS
Individual Assignment Activity of Unit 5: (option)
Run the Lab: Medical Image Segmentation with DIGITS
https://nvidia.qwiklab.com/users/sign_in?locale=en
https://www.nvidia.com/en-us/deep-learning-ai/education/

How to evaluate a classifier?

- Machines make mistake

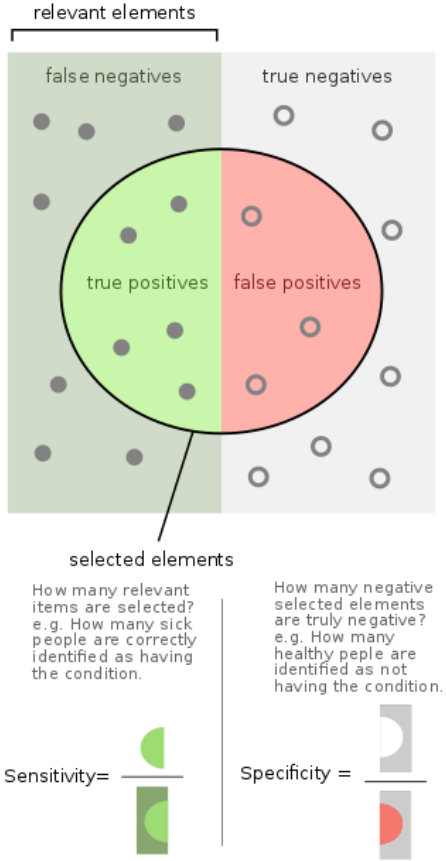
	Positive	Negative
True	TP	NT
False	FP	FN

Concepts of Machine Learning

- Data acquisition and preprocessing
- Design Model
- Selecting Suitable Algorithm
- Parameters adjustment(training)
- Prediction
- Feedback results to modify parameters

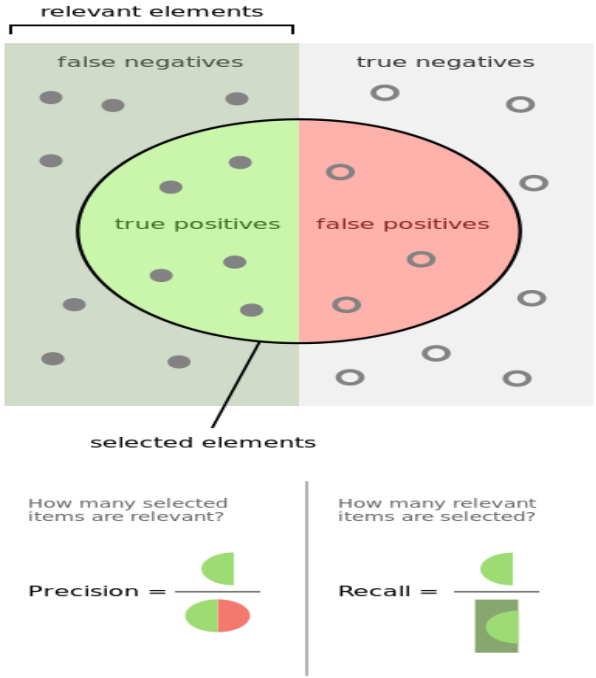
Evaluation of Classifier

- True Positive （TP）
- True Negative（TN）
- False Positive （假正, FP）
- False Negative（假負 , FN）
- True Positive Rate（TPR）or（sensitivity）
- TPR = TP / (TP + FN)
- True Negative Rate（TNR）or（specificity）
- TNR = TN / (TN + FP)
- False Positive Rate （FPR）
- FPR = FP / (FP + TN)
- False Negative Rate（FNR）
- FNR = FN / (TP + FN)
- Source:
- https://en.wikipedia.org/wiki/Sensitivity_and_specificity
- https://en.wikipedia.org/wiki/False_positives_and_false_negatives



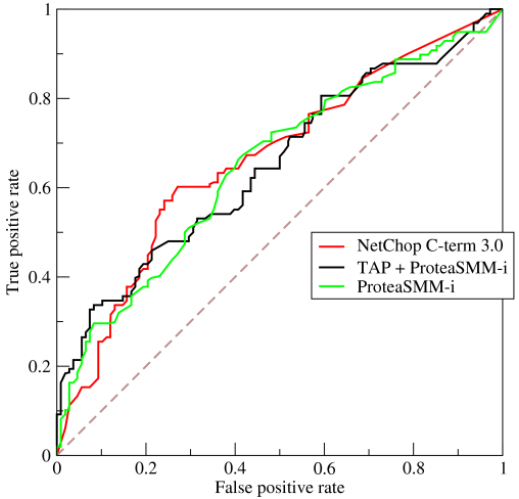
Evaluation of Classifier

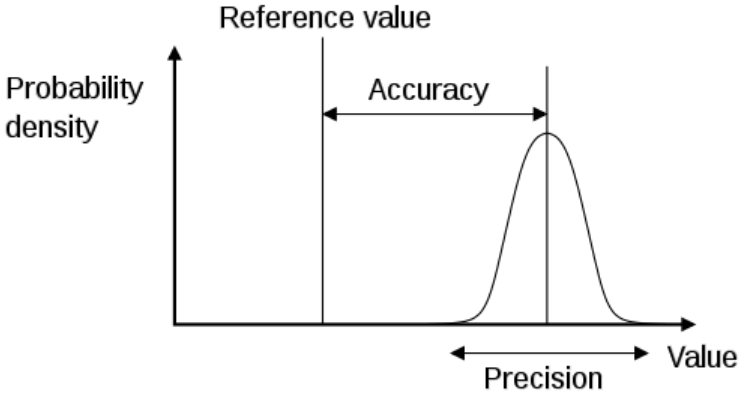
- True Positive (檢查有病也有病)



Evaluation of Classifier

- Receiver Operating Characteristic (ROC)
- Area under the Curve of ROC (AUC ROC))
- This curve plays a central role in evaluating diagnostic ability of tests to discriminate the true state of subjects, finding the optimal cut off values, and comparing two alternative diagnostic tasks when each task is performed on the same subject





Evaluation of Classifier

- Statistics
- Null and Alternative Hypothesis
- There are two types of **errors**:
- **Type I** – H0 is rejected even though it is true (**false positive**)
- **Type II** – H0 is not rejected even though it is false (**false negative**)

Evaluation of Classifier

- Significance level is the acceptable level of type I error, denoted α. Typically, a significance level of α = .05 is used (although sometimes other levels such as α = .01 may be employed).
- This means that we are willing to tolerate up to 5% of type I errors,
- i.e. we are willing to accept the fact that in 1 out of every 20 samples we reject the null hypothesis even though it is true.

Evaluation of Classifier

- P-value (the probability value) is the value p of the statistic used to test the null hypothesis. If $p < \alpha$ then we reject the null hypothesis.

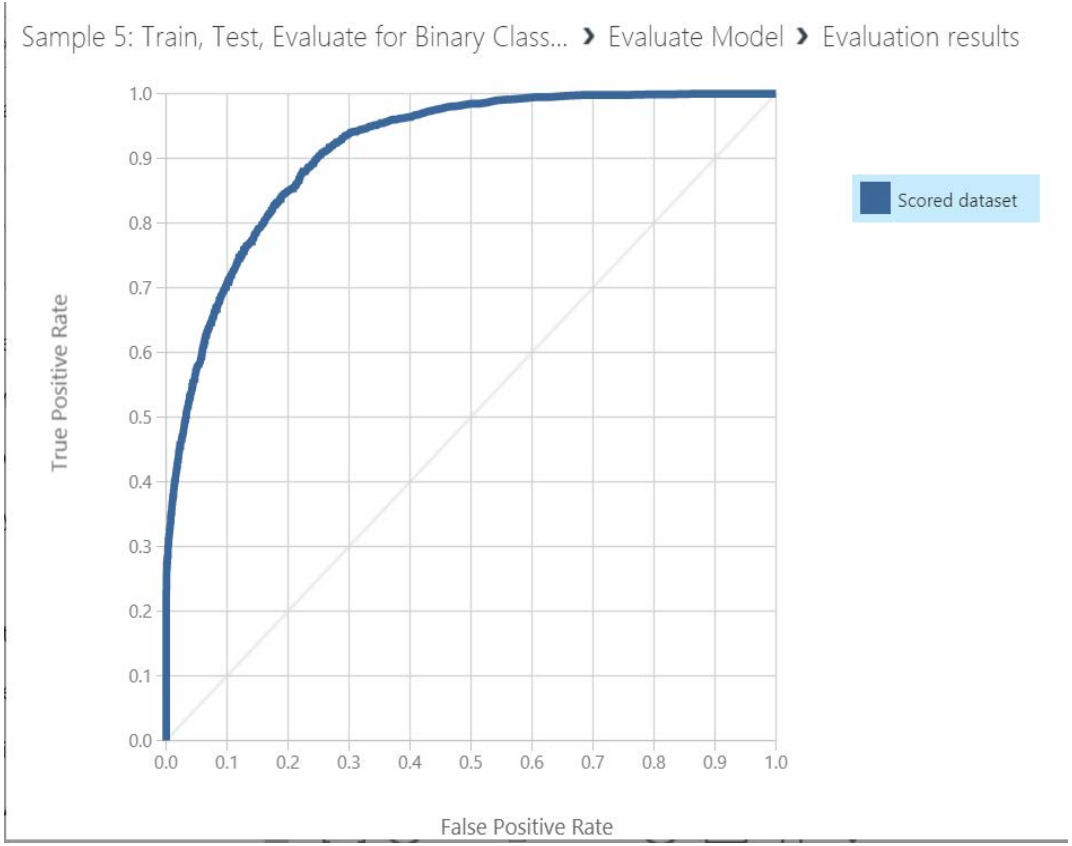
Azure Machine Learning

- Predict Annual Income
- Will somebody earn over 50k a year?
- Step 1: Getting the data
- Step 2: Select required columns
- Step 3: Clean missing data
- Step 4: Inspect the data
- Step 5: Take care of the variable types
- Step 6: Split the dataset into a training and a test set

Azure Machine Learning

- Step 7: Train the basic model
- Step 8: Evaluate the Feature Importance
- Step 9: Score the test data
- Step 10: Evaluate the model

ref.


Sample 5: Train, Test, Evaluate for Binary Class... › Evaluate Model › Evaluation results
True Positive Rate
False Positive Rate
Scored dataset
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Microsoft Power BI

- Machine learning tutorial: Create your first data science experiment in Azure Machine Learning Studio
- https://docs.microsoft.com/en-us/azure/machine-learning/studio/create-experiment

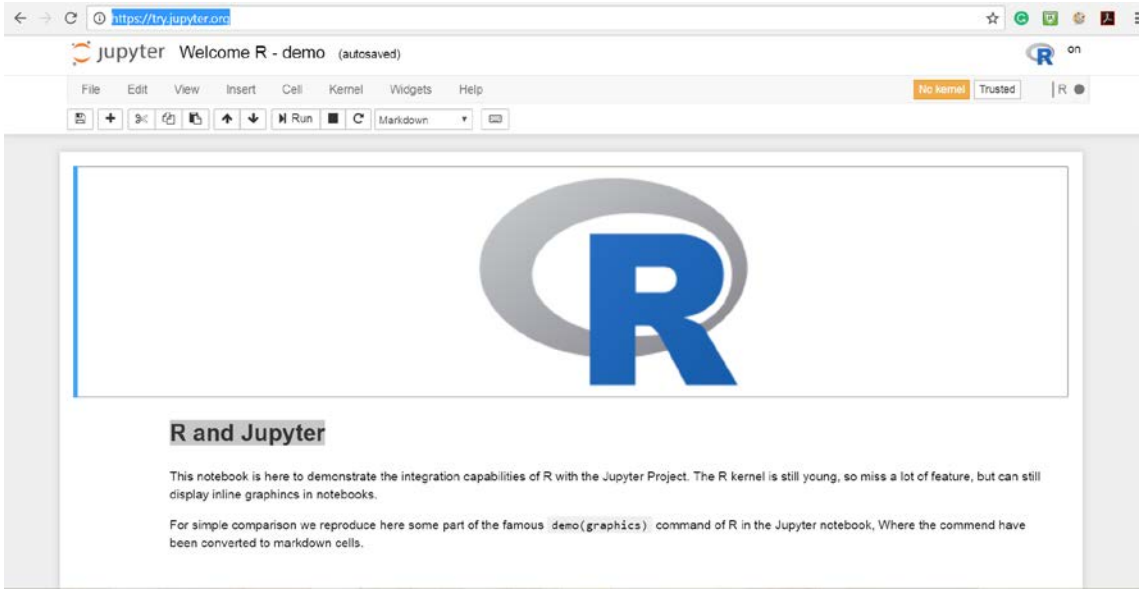
Five steps to create an experiment

In this machine learning tutorial, you'll follow five basic steps to build an experiment in Machine Learning Studio to create, train, and score your model:

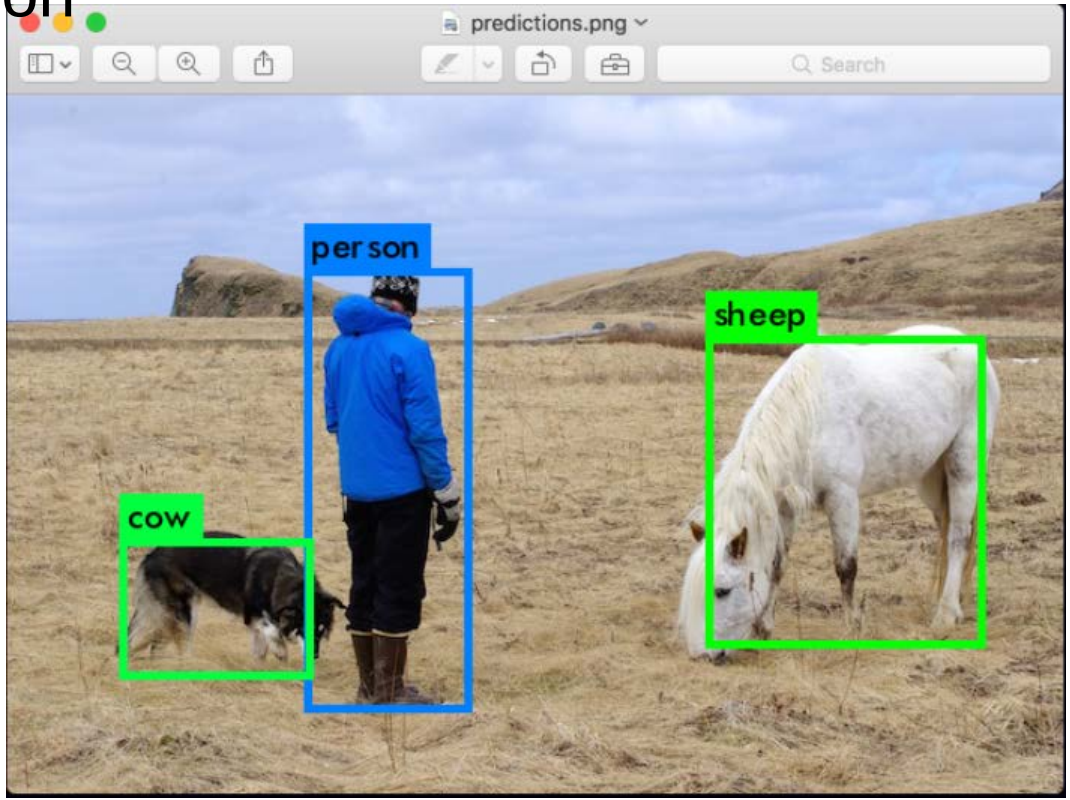
- **Create a model**
  - Step 1: Get data
  - Step 2: Prepare the data
  - Step 3: Define features
- **Train the model**
  - Step 4: Choose and apply a learning algorithm
- **Score and test the model**
  - Step 5: Predict new automobile prices

R and Jupyter

- https://try.jupyter.org/



Real-Time Object Detection & Recognition



Real-Time Detection

- Real-Time Detection on a Webcam
- Running YOLO on test data isn't very interesting if you can't see the result. Instead of running it on a bunch of images let's run it on the input from a webcam!
- To run this demo you will need to compile Darknet with CUDA and OpenCV. Then run the command:./darknet detector demo cfg/coco.data cfg/yolo.cfg yolo.weights

Image Classification

1. Nvidia lab

2.Training Experiment

3.Prediction Experiment

Image Classification with DIGITS

- Nvidia 雲端網站 https://nvidia.qwiklab.com/users/sign_in?locale=en

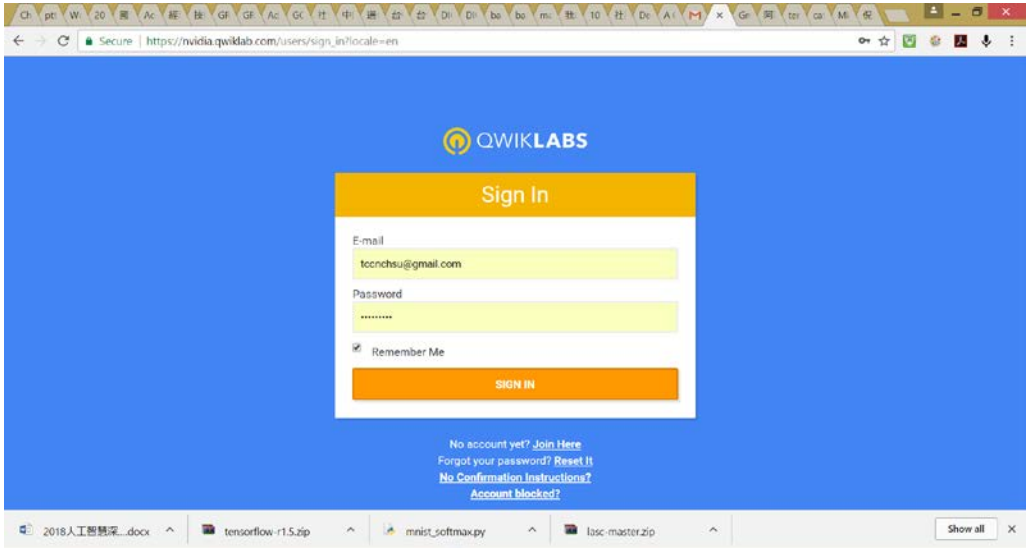


Image Classification with DIGITS

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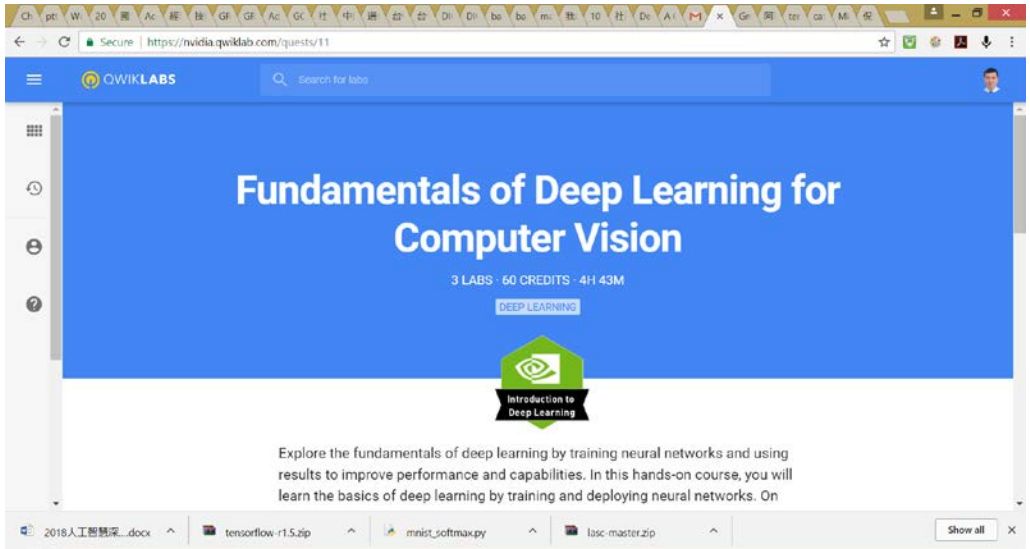

Image Classification with DIGITS

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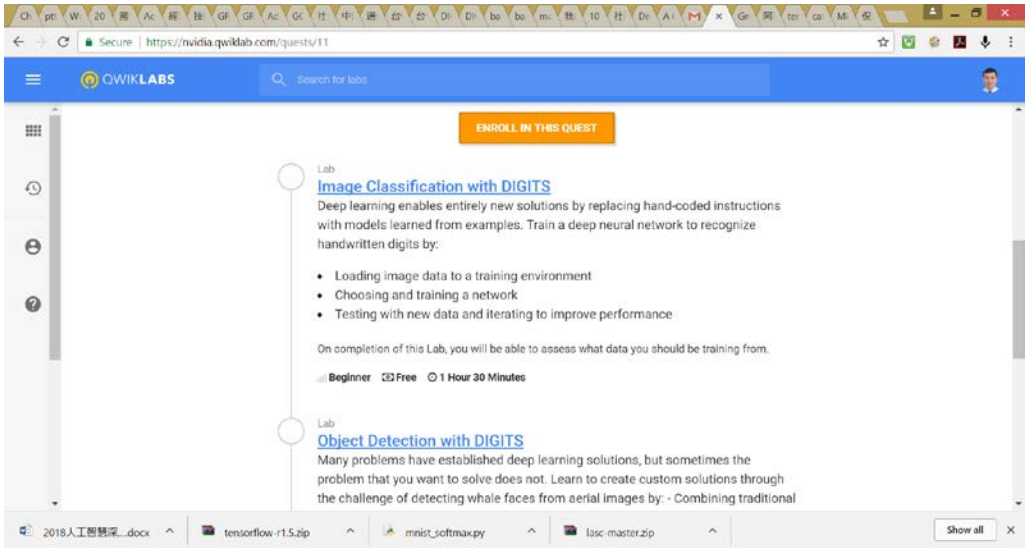
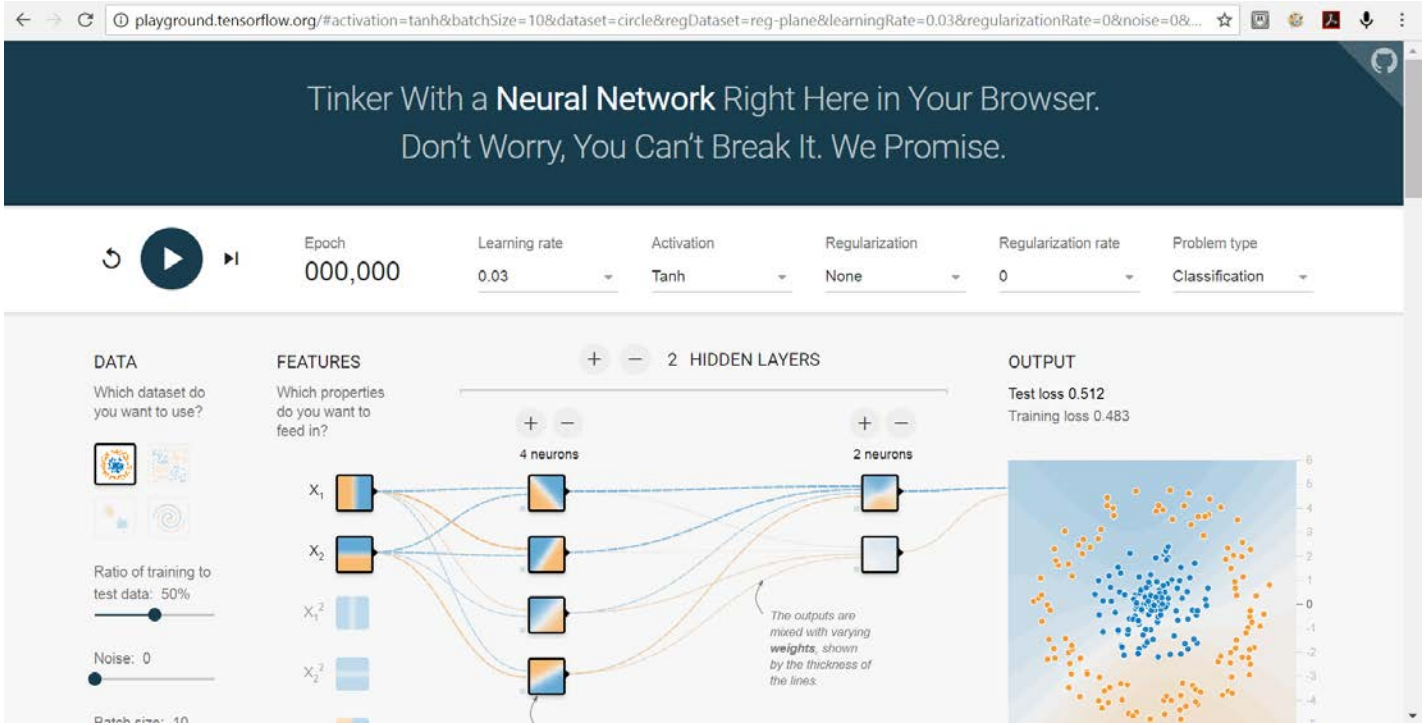


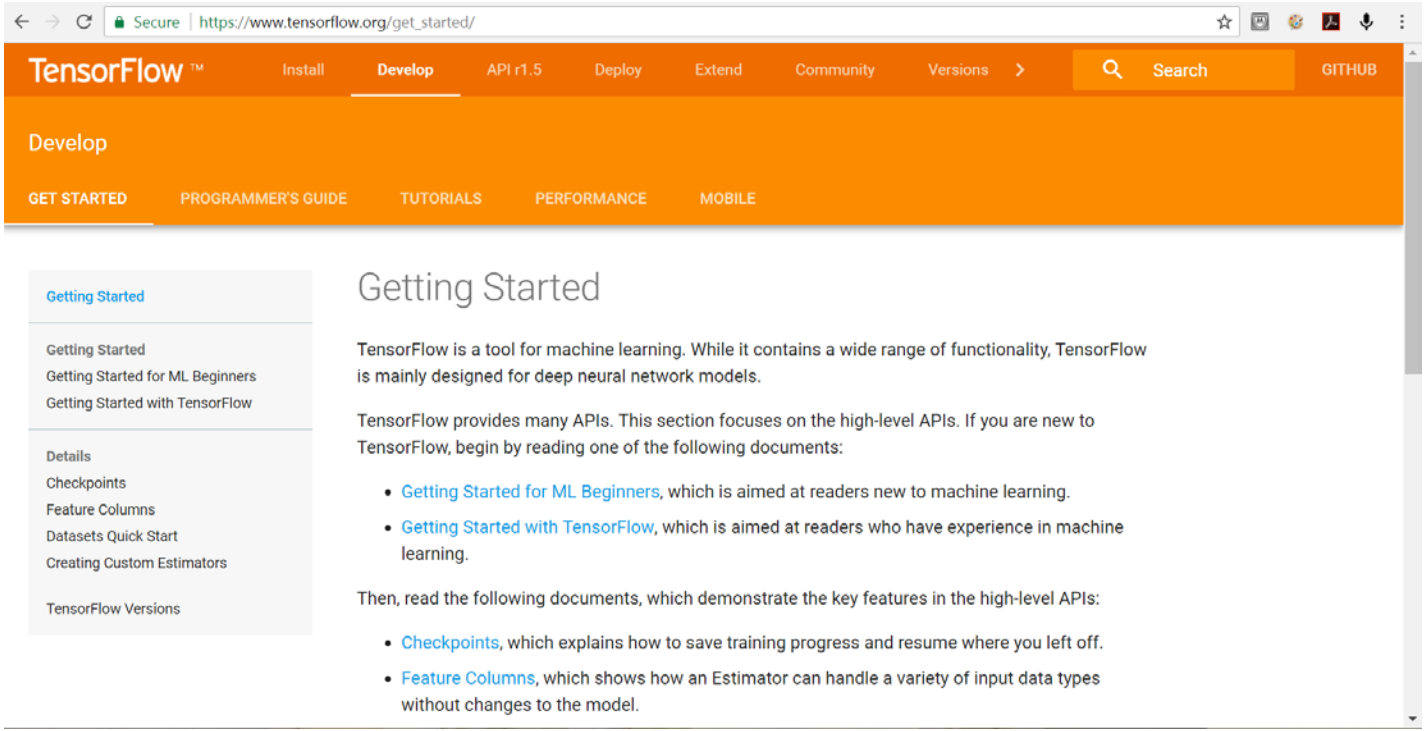
影像分類

- 影像數據分析理論與案例
  - 1.運用 Google Tensorflow 建立你的影像分類專案
  - 2.訓練實驗
  - 3.預測實驗

Play Neural Network

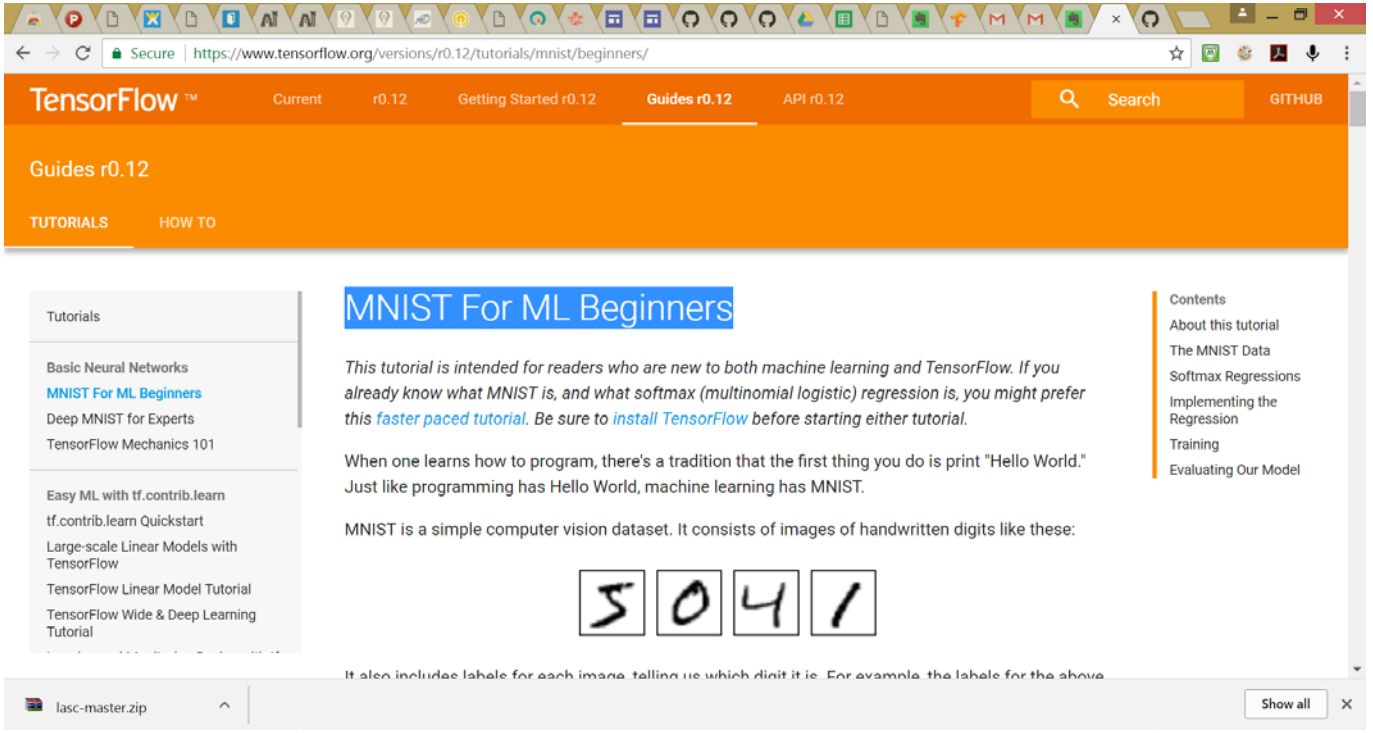
- Tinker With a Neural Network Right Here in Your Browser.
- Don’t Worry, You Can’t Break It. We Promise.
- http://playground.tensorflow.org/


playground.tensorflow.org/#activation=tanh&batchSize=10&dataset=circle&regDataset=reg-plane&learningRate=0.03&regularizationRate=0&noise=0&...
Tinker With a Neural Network Right Here in Your Browser.
Don't Worry, You Can't Break It. We Promise.
Epoch
000,000
Learning rate
0.03
Activation
Tanh
Regularization
None
Regularization rate
0
Problem type
Classification
DATA
Which dataset do you want to use?
Ratio of training to test data: 50%
Noise: 0
FEATURES
Which properties do you want to feed in?
2 HIDDEN LAYERS
4 neurons
2 neurons
The outputs are mixed with varying weights, shown by the thickness of the lines.
OUTPUT
Test loss 0.512
Training loss 0.483


Secure | https://www.tensorflow.org/get_started/
TensorFlow ™
Install
Develop
API r1.5
Deploy
Extend
Community
Versions
Search
GITHUB
Develop
GET STARTED
PROGRAMMER'S GUIDE
TUTORIALS
PERFORMANCE
MOBILE
Getting Started
Getting Started
Getting Started for ML Beginners
Getting Started with TensorFlow
Details
Checkpoints
Feature Columns
Datasets Quick Start
Creating Custom Estimators
TensorFlow Versions
Getting Started
TensorFlow is a tool for machine learning. While it contains a wide range of functionality, TensorFlow is mainly designed for deep neural network models.
TensorFlow provides many APIs. This section focuses on the high-level APIs. If you are new to TensorFlow, begin by reading one of the following documents:
Getting Started for ML Beginners, which is aimed at readers new to machine learning.
Getting Started with TensorFlow, which is aimed at readers who have experience in machine learning.
Then, read the following documents, which demonstrate the key features in the high-level APIs:
Checkpoints, which explains how to save training progress and resume where you left off.
Feature Columns, which shows how an Estimator can handle a variety of input data types without changes to the model.

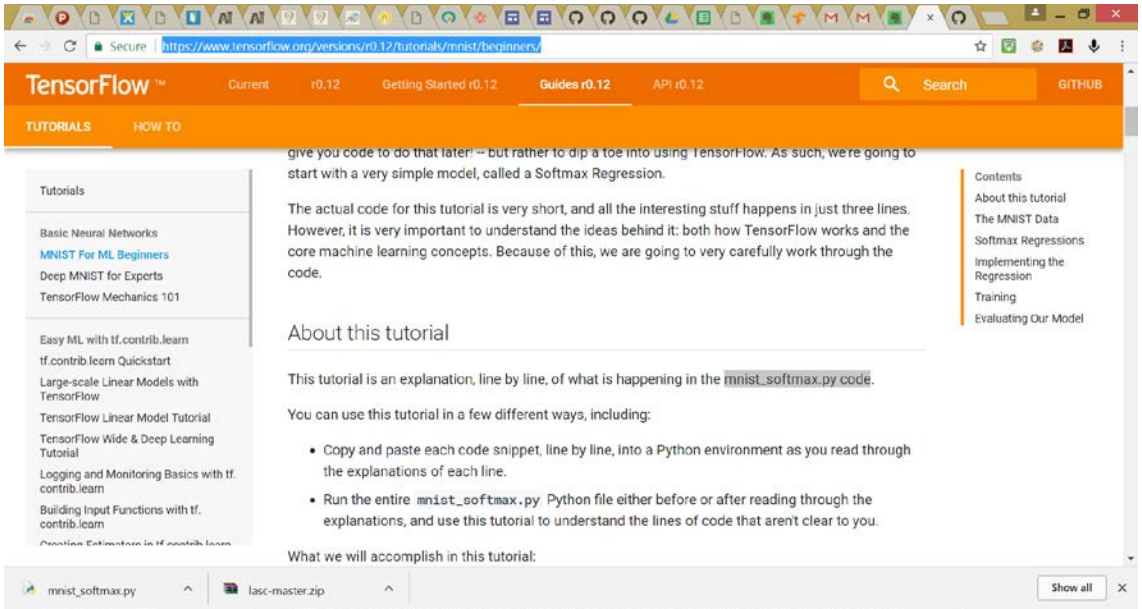
MNIST For ML Beginners

- https://www.tensorflow.org/versions/r0.12/tutorials/mnist/beginners/



MNIST For ML Beginners

- https://www.tensorflow.org/versions/r0.12/tutorials/mnist/beginners/
- Download mnist_softmax.py code(下載檔是html)

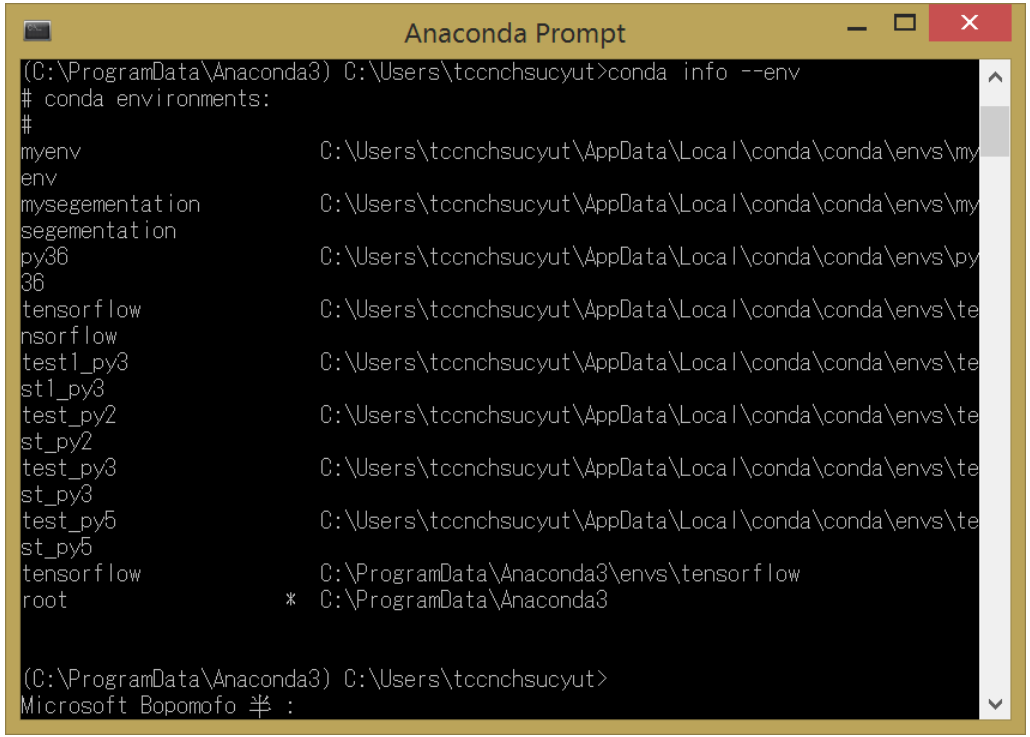


Anaconda Proimpt

- Anaconda Prompt

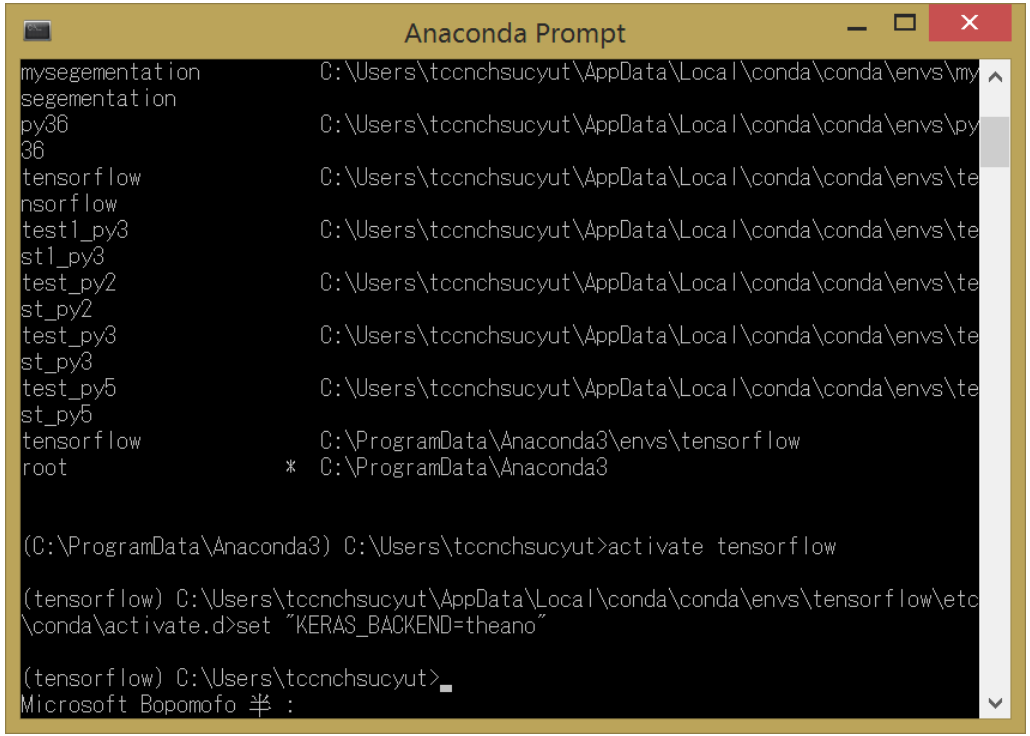
Anaconda Proimpt

- conda info --env



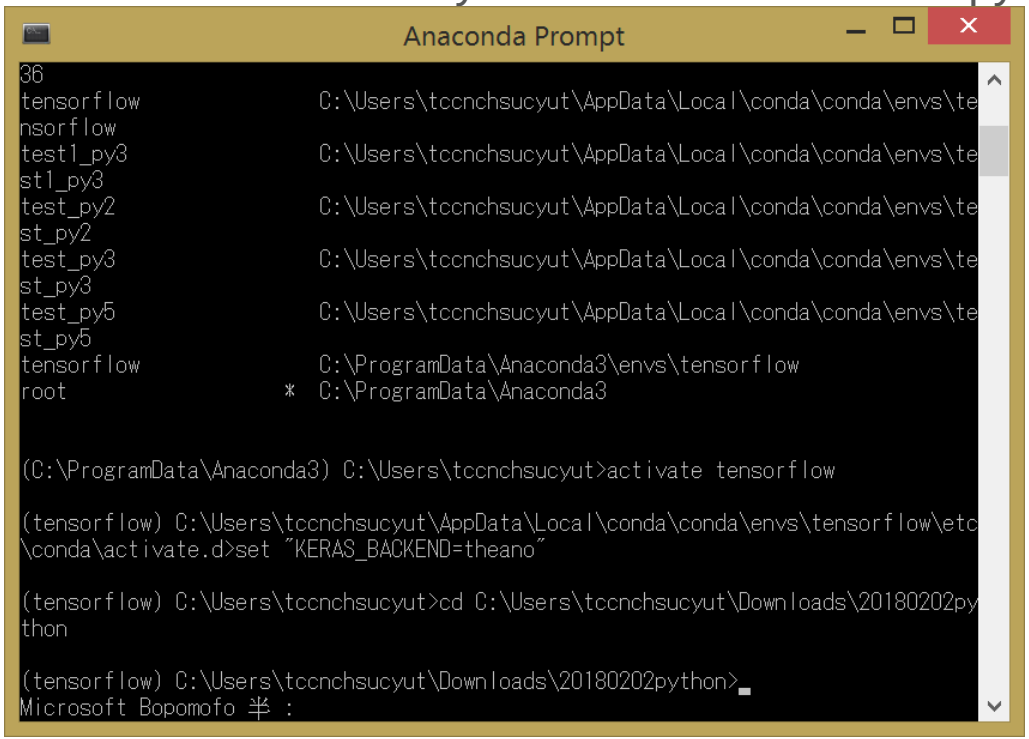
Anaconda Proimpt

- activate tensorflow



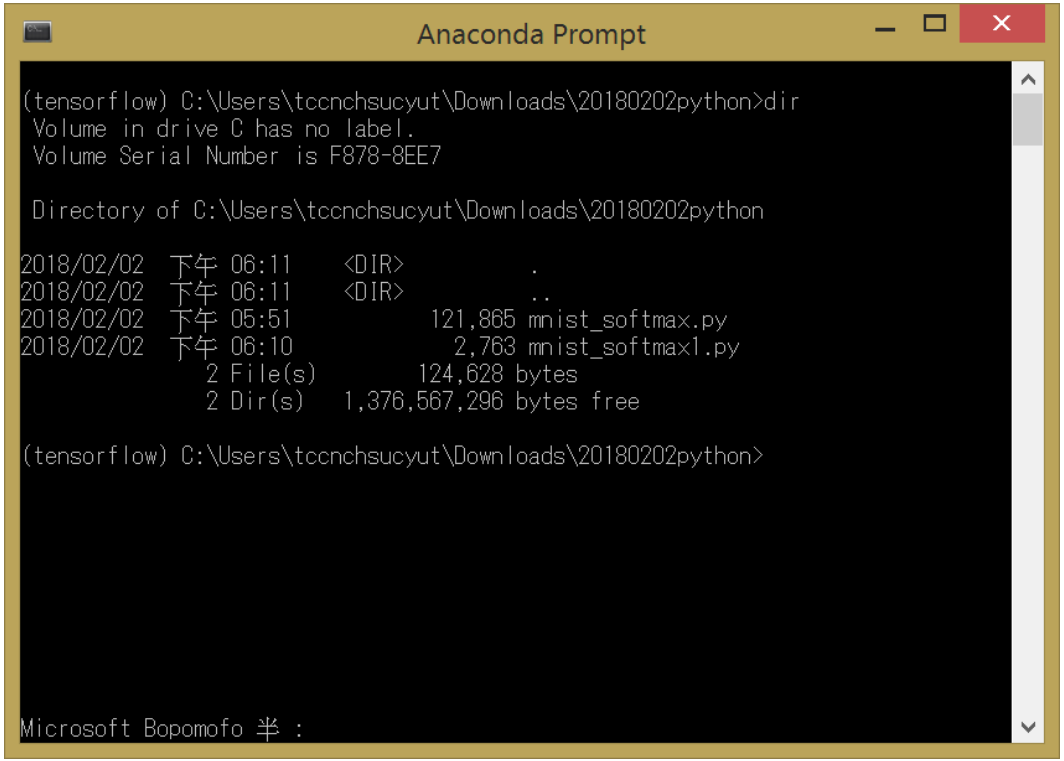
Anaconda Proimpt

- cd C:\Users\tccnchsucyut\Downloads\20180202python



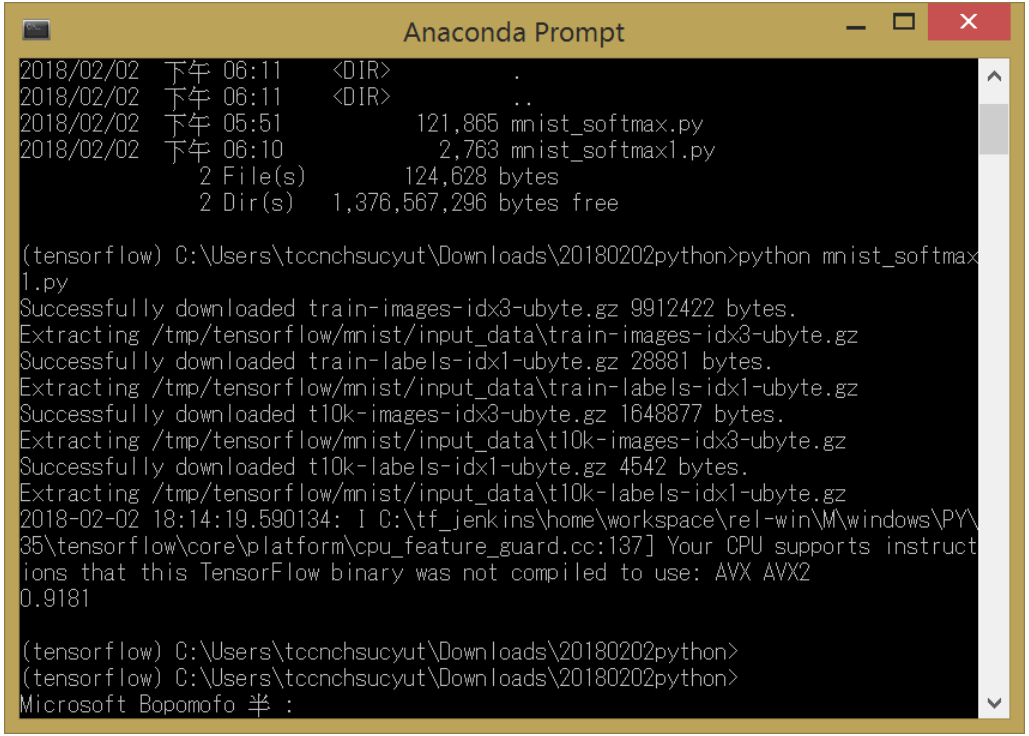
Anaconda Proimpt

- dir



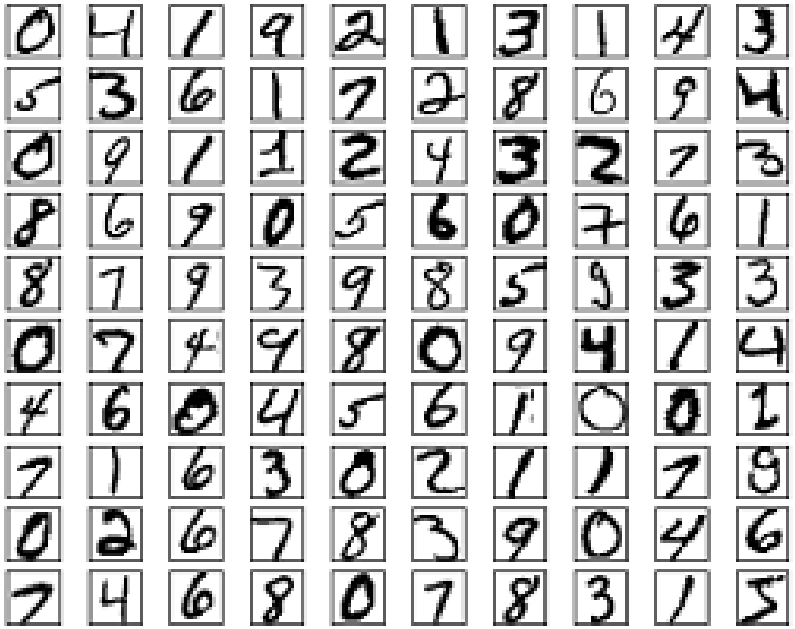
Anaconda Proimpt

- python mnist_softmax1.py (下載檔是mnist_softmax 是html)



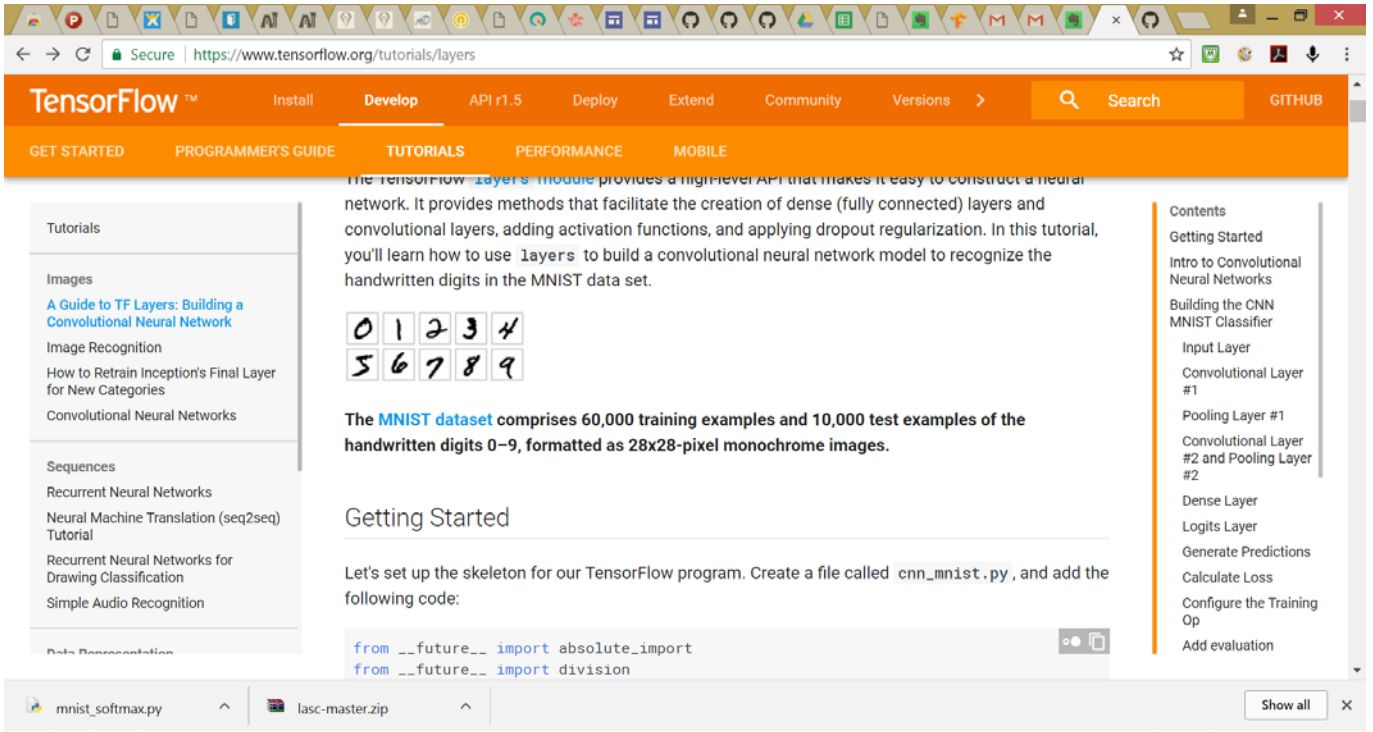
handwritten digits

- a large number of handwritten digits, known as training examples,



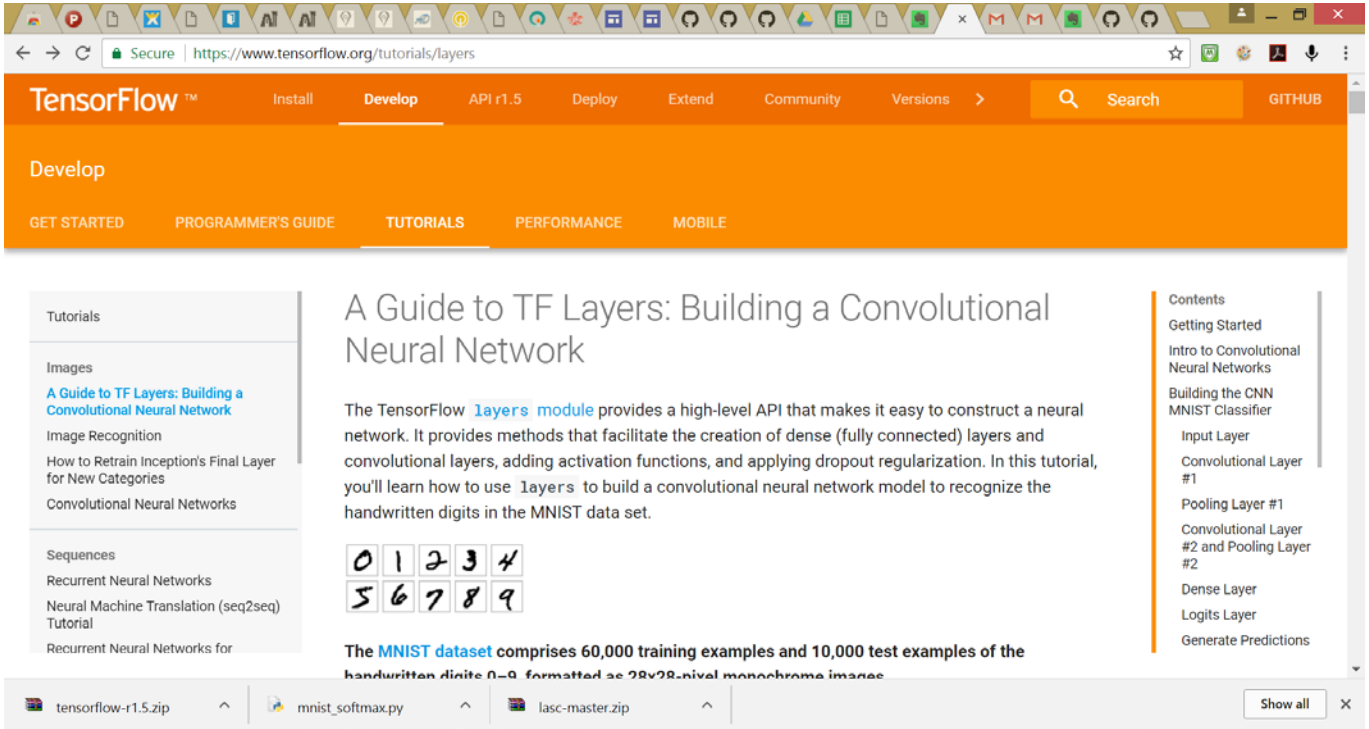
Convolutional Neural Network

- A Guide to TF Layers: Building a Convolutional Neural Network



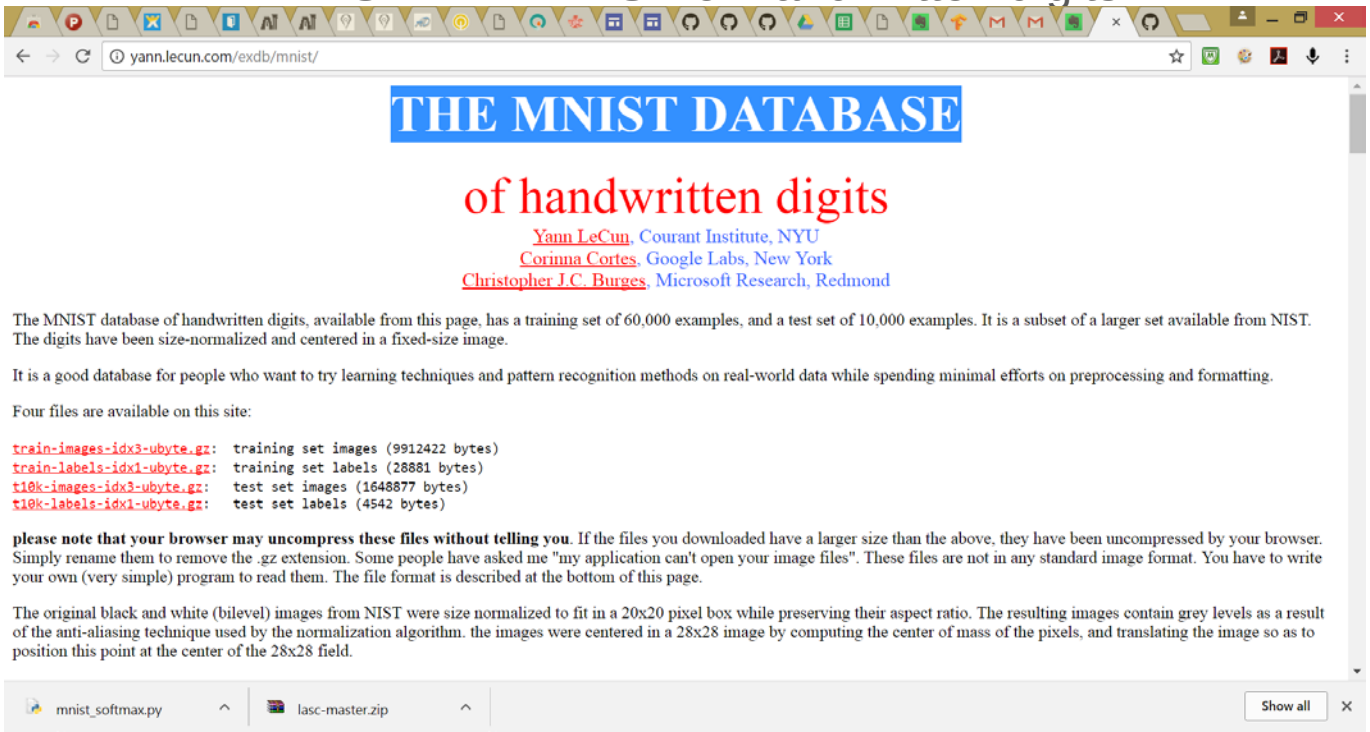
A Guide to TF Layers: Building a Convolutional Neural Network

- https://www.tensorflow.org/tutorials/layers



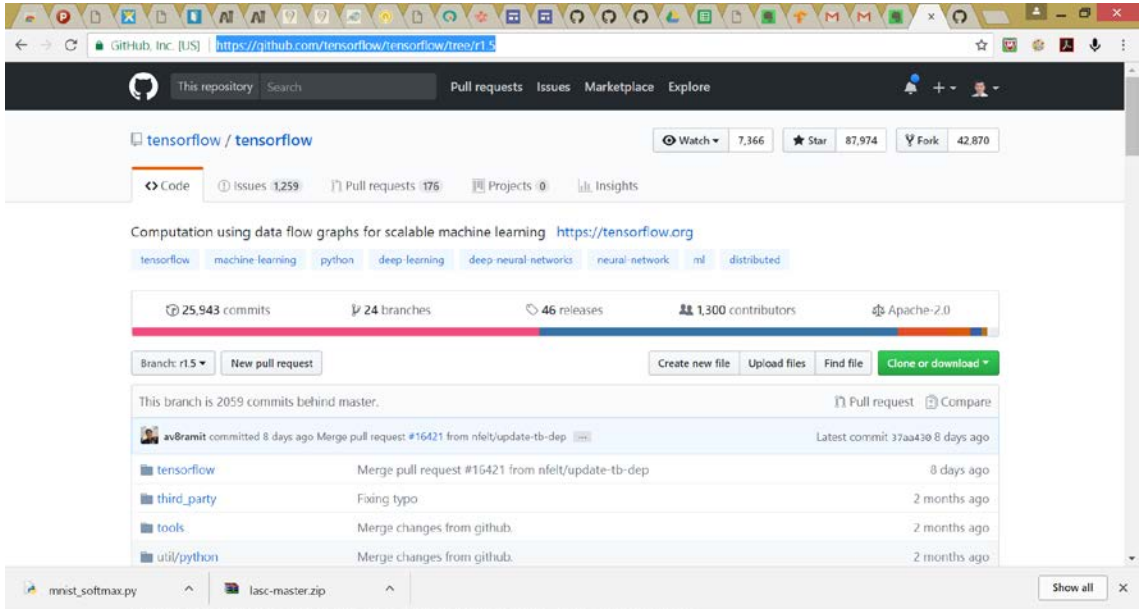
THE MNIST DATABASE

- THE MNIST DATABASE of handwritten digits



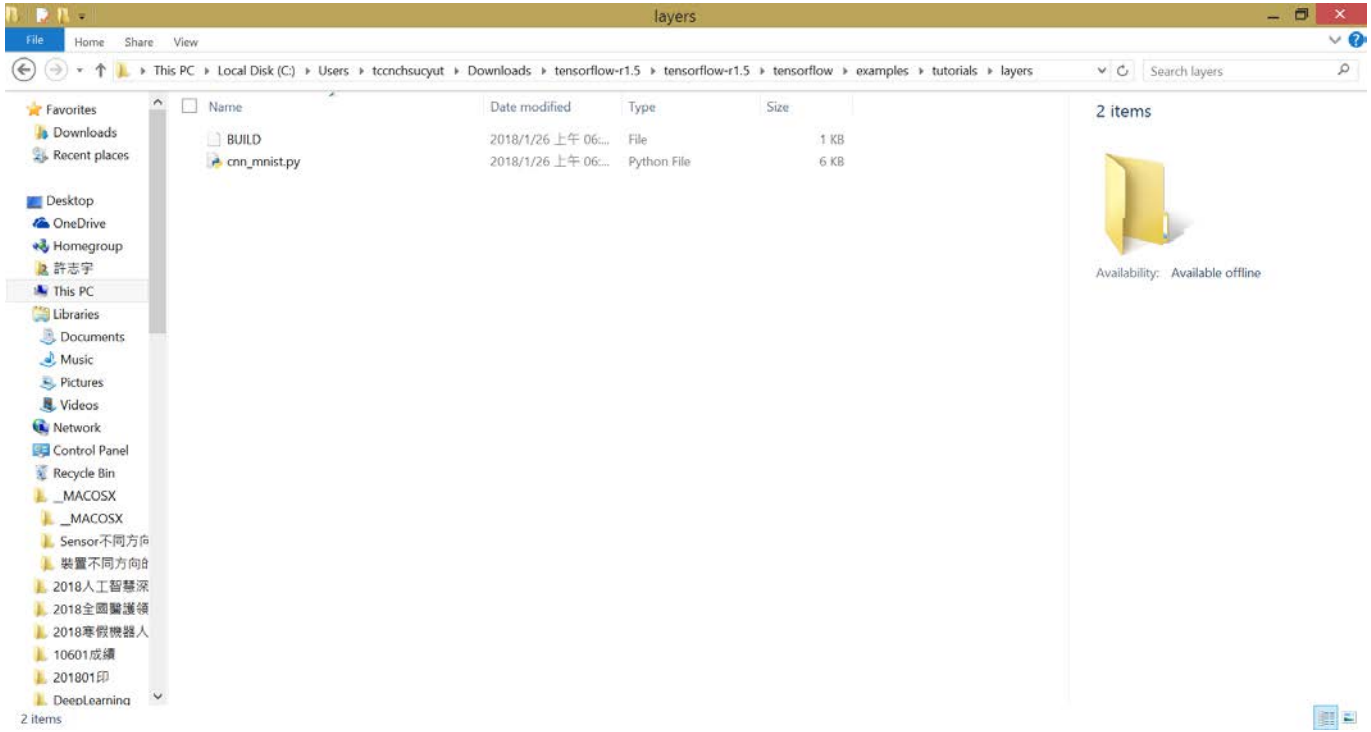
THE MNIST DATABASE

- tensorflow/tensorflow
- https://github.com/tensorflow/tensorflow/tree/r1.5



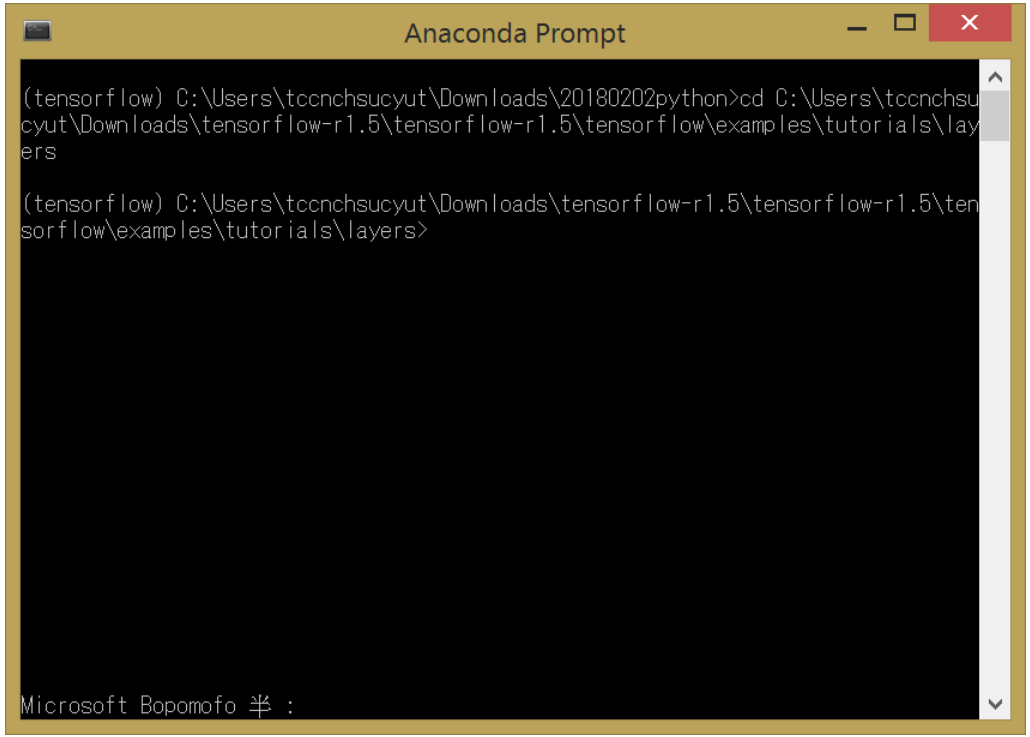
Anaconda Proimpt

clone->tensorflow-r.5.zip
Unzip
C:\Users\tccnchsucyut\Downloads\tensorflow-r1.5\tensorflow-r1.5\tensorflow\examples\tutorials\layers



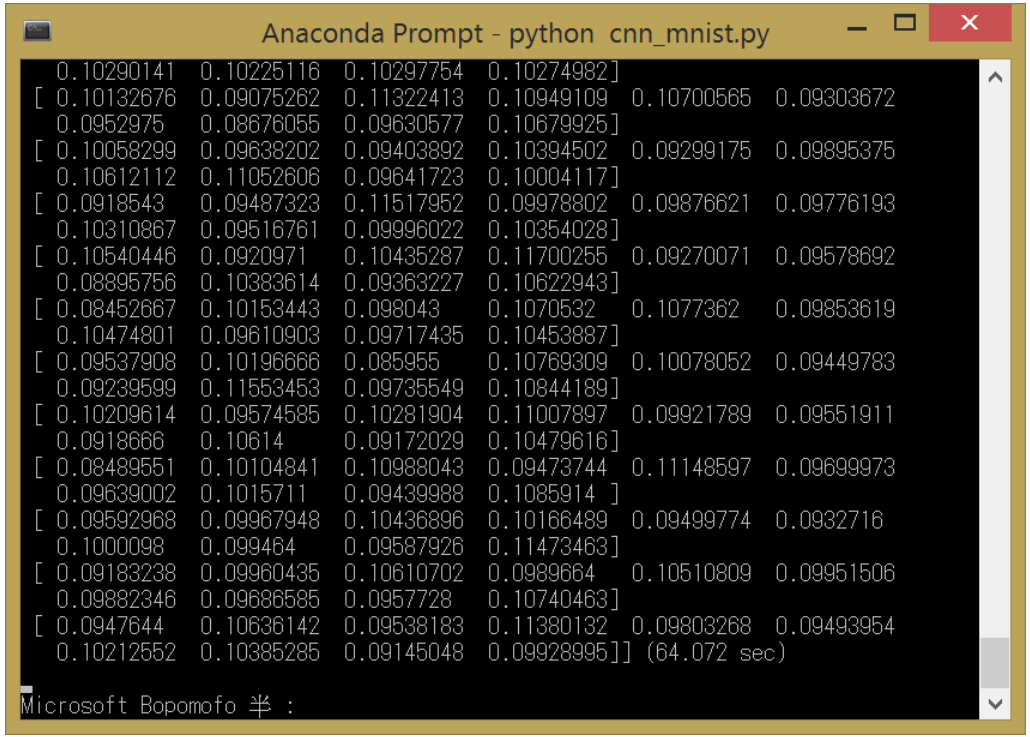
Anaconda Proimpt

clone->tensorflow-r.5.zip
Unzip
cd C:\Users\tccnchsucyut\Downloads\tensorflow-r1.5\tensorflow-r1.5\tensorflow\examples\tutorials\layers



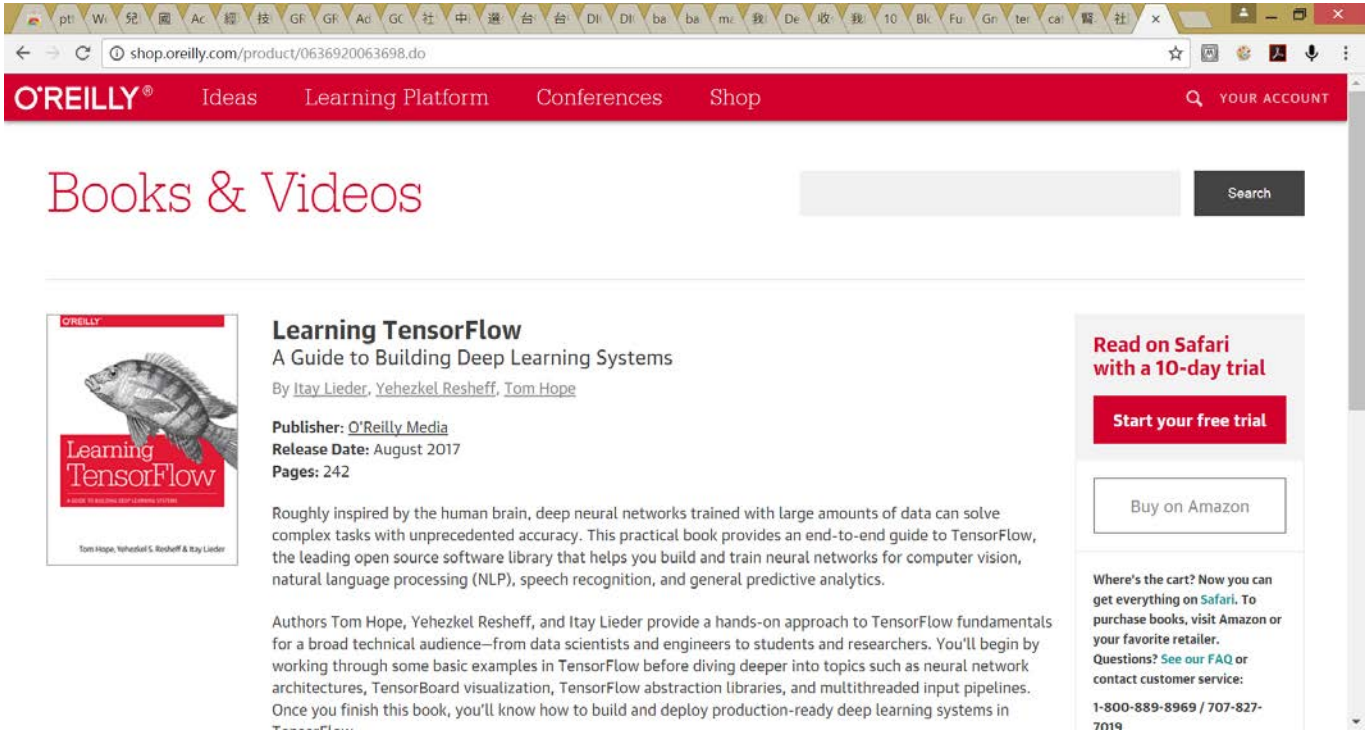
Anaconda Proimpt

- python cnn_mnist.py



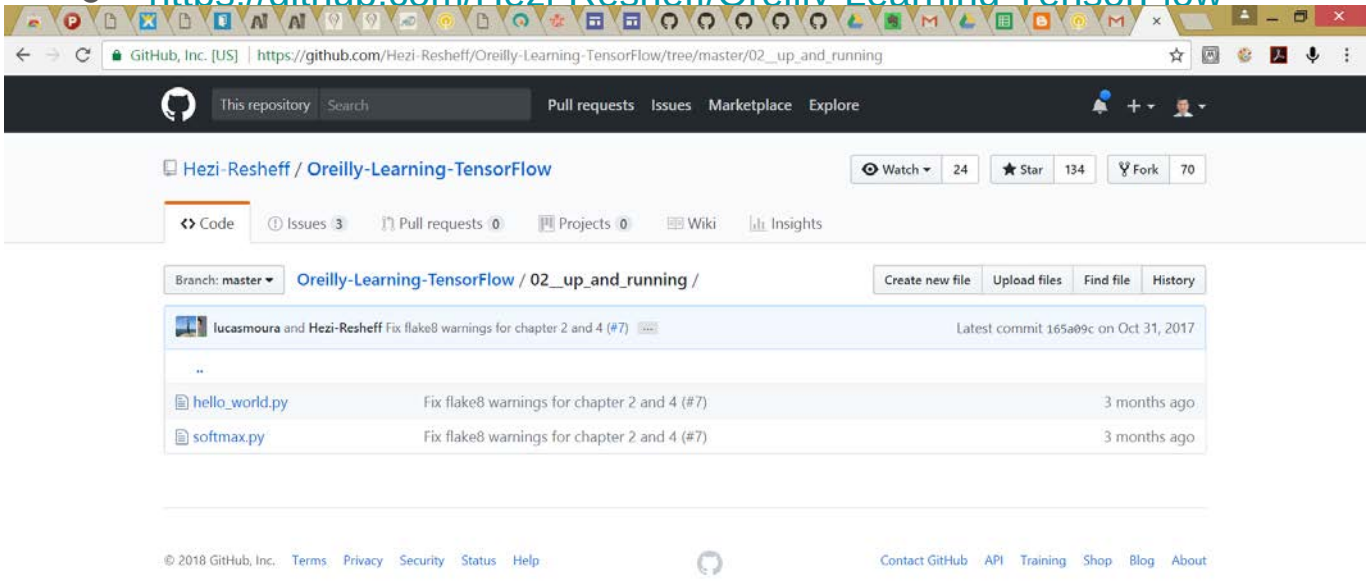
Learning TensorFlow A Guide to Building Deep Learning Systems

- http://shop.oreilly.com/product/0636920063698.do



Hezi-Resheff/Oreilly-Learning-TensorFlow

- https://github.com/Hezi-Resheff/Oreilly-Learning-TensorFlow



Hezi-Resheff/Oreilly-Learning-TensorFlow

- https://github.com/Hezi-Resheff/Oreilly-Learning-TensorFlow/tree/master/02__up_and_running
- 隨堂測驗
- 執行 softmax.py

softmax.py

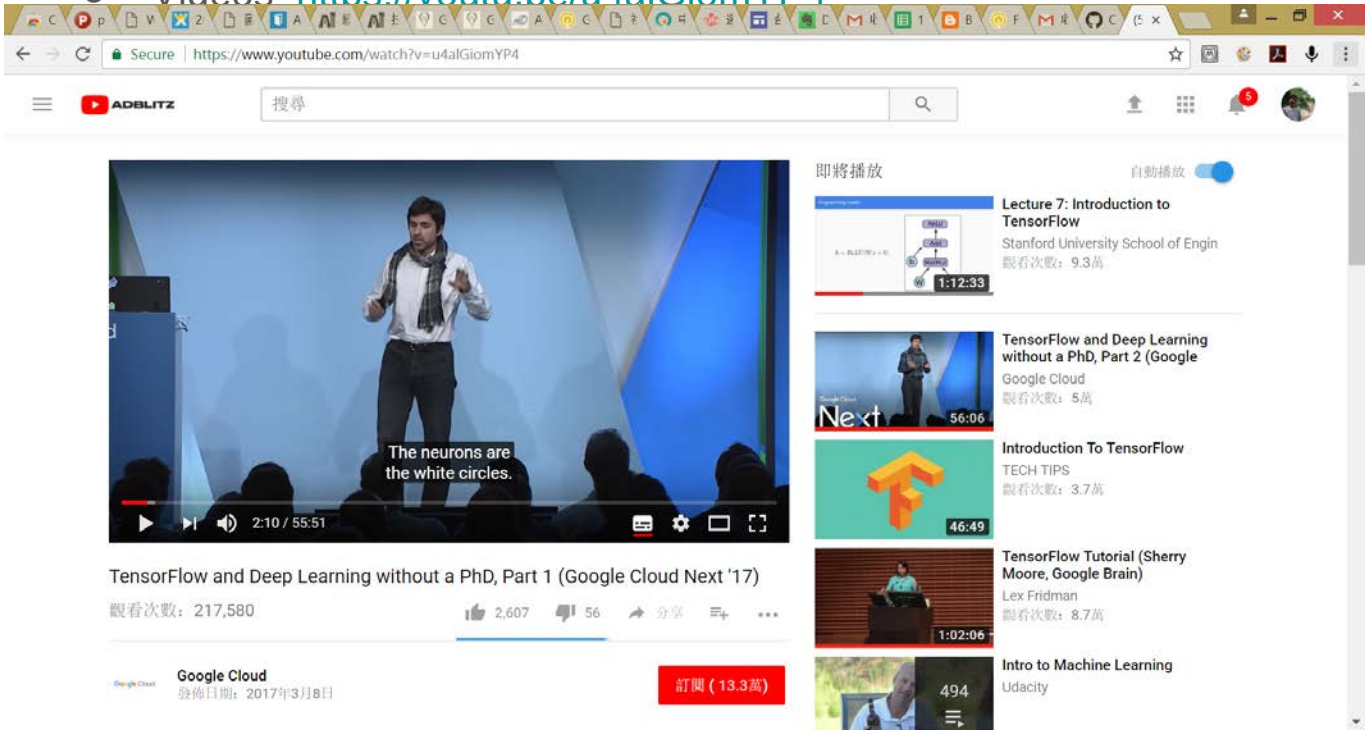
```
import tensorflow as tf
from tensorflow.examples.tutorials.mnist import input_data

DATA_DIR = '/tmp/data'
NUM_STEPS = 1000
MINIBATCH_SIZE = 100
data = input_data.read_data_sets(DATA_DIR, one_hot=True)
x = tf.placeholder(tf.float32, [None, 784])
W = tf.Variable(tf.zeros([784, 10]))
y_true = tf.placeholder(tf.float32, [None, 10])
y_pred = tf.matmul(x, W)
cross_entropy = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits(
    logits=y_pred, labels=y_true))
gd_step = tf.train.GradientDescentOptimizer(0.5).minimize(cross_entropy)
correct_mask = tf.equal(tf.argmax(y_pred, 1), tf.argmax(y_true, 1))
accuracy = tf.reduce_mean(tf.cast(correct_mask, tf.float32))
```

softmax.py

- with tf.Session() as sess:
- # Train
- sess.run(tf.global_variables_initializer())
- for _ in range(NUM_STEPS):
- batch_xs, batch_ys = data.train.next_batch(MINIBATCH_SIZE)
- sess.run(gd_step, feed_dict={x: batch_xs, y_true: batch_ys})
- # Test
- ans = sess.run(accuracy, feed_dict={x: data.test.images, y_true: data.test.labels})
- print("Accuracy: {:.4}%".format(ans*100))

softmax.py

- Videos https://youtu.be/u4alGiomYP4



The study plan

- Short-Term Project Report Presentation

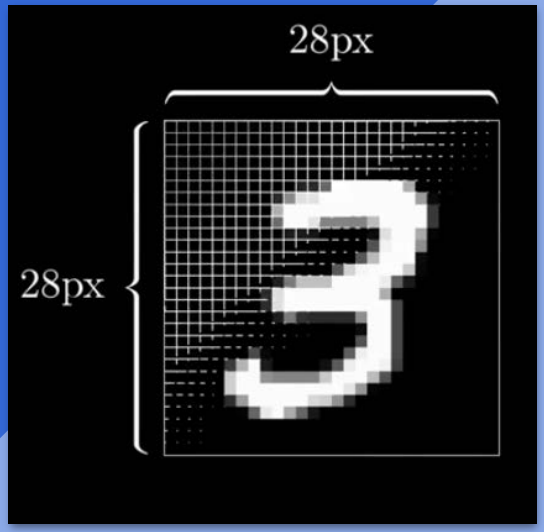
Major Course Assignments

- In-Class activity, assignment done in class
- Individual assignment at home
- Short-Term Project in teams

Major Course Assignments

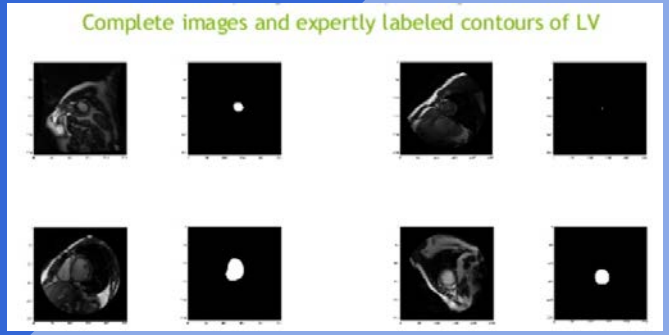
Individual Assignment Activity of Unit 3:
Run the Lab: Image Classification with DIGITS
Individual Assignment Activity of Unit 5: (option)
Run the Lab: Medical Image Segmentation with DIGITS
https://www.nvidia.com/en-us/deep-learning-ai/education/

Individual Assignment Activity of Unit 3:



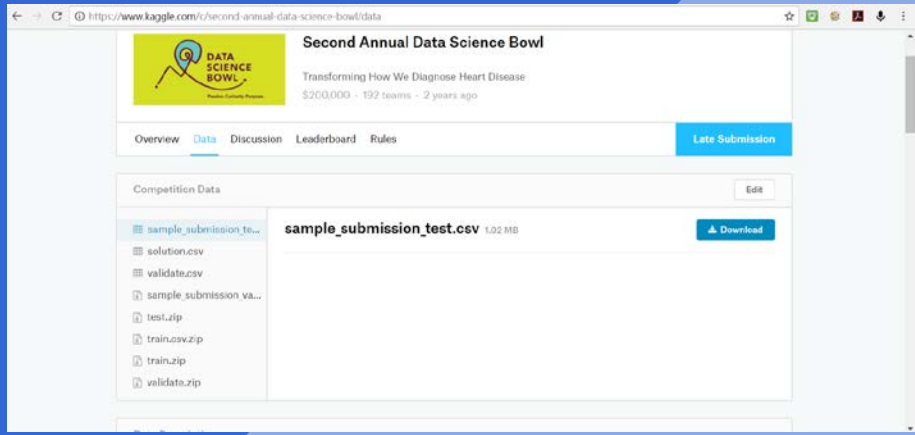
- Learn how to leverage deep neural networks (DNN) within the deep learning workflow to recognize handwritten characters using NVIDIA DIGITS™.

Short-Term Project in teams



- Segment MRI images to measure parts of the heart by setting up a computer vision workflow using deep learning.

Short-Term Project Dataset



- Data Science Bowl Competition
  Second Annual Data Science Bowl
- Transforming How We Diagnose Heart Disease
- https://www.kaggle.com/c/second-annual-data-science-bowl

Short-Term Project in teams

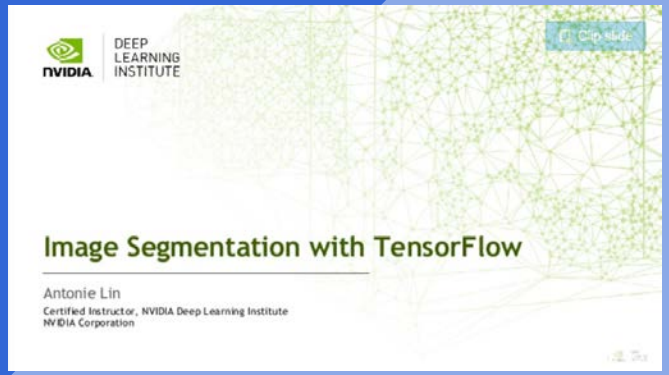
After completing this project, you will:

- Know how Convolutional Neural Networks (CNNs) work.
- Know how to prepare data for CNNs.
- Know how to design architecture of CNNs.
- Know how to tune CNNs to a problem.
- Know how to save an CNN model and use it to make predictions.

Short-Term Project Report

Report Contents involved as follows:
Section 1: Overview of concepts of Deep Neural Networks
Section 2: Design a CNNs architecture for medical image segmentation.
Section 3: Impemetation of the CNNs architecture in Tensorflow and Python.
Section 4: Evaluation of the Design of a CNNs architecture.

Short-Term Project Resources

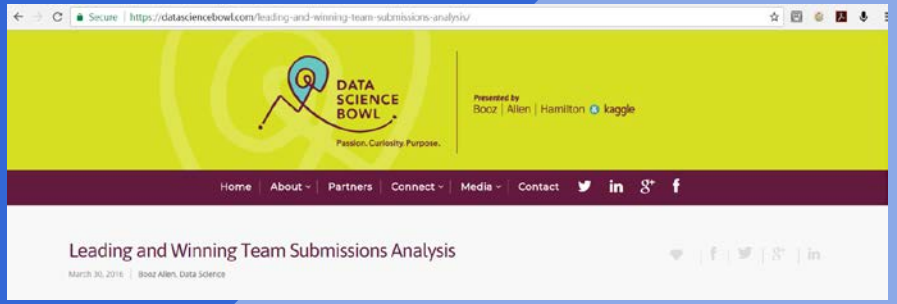


- Introduction to Image Segmentation with TensorFlow
- https://www.slideshare.net/NVIDIATaiwan/nvidia-dli-image-segmentation-with-tensorflow

Short-Term Project Resources

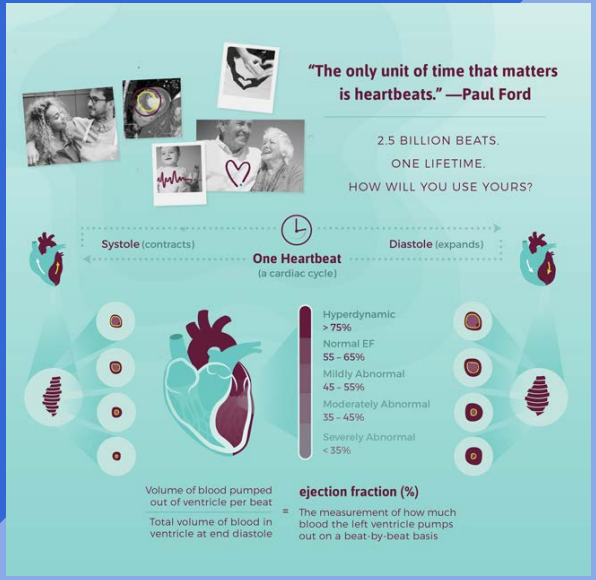
- Diagnosing Heart Diseases in the Data Science Bowl: 2nd place, Team kunsthart
- http://blog.kaggle.com/2016/04/13/diagnosing-heart-diseases-with-deep-neural-networks-2nd-place-ira-korshunova/

Short-Term Project Resources



- Leading and Winning Team Submissions Analysis
- https://datasciencebowl.com/leading-and-winning-team-submissions-analysis/

Short-Term Project Resources



- **Left Atrial Segmentation Challenge 2013**
- https://github.com/catactg/lasc

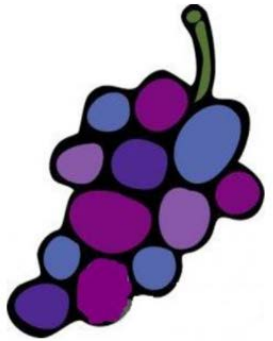
Short-Term Project Resources

- Using DIGITS to train a medical image segmentation network
- https://github.com/NVIDIA/DIGITS/tree/master/examples/medical-imaging

Let the course make you feel like eating Grapes!

GRAPE Retention

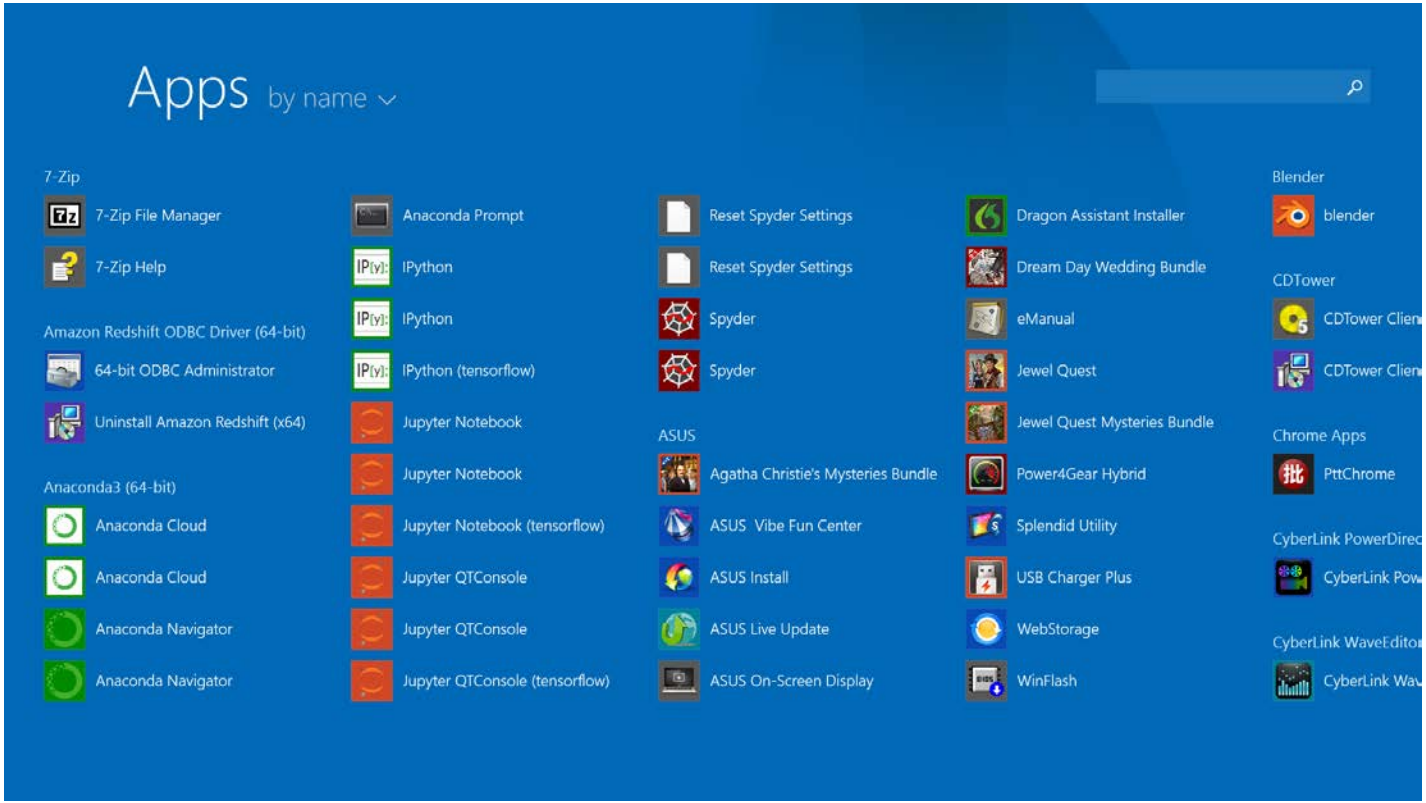
- **G**rowth
- **R**ecognition
- **A**chievement
- **P**articipation
- **E**njoyment



Make you Growth. Make you Recognition.
Make you Achievement. Make you Participation.
Make you Enjoyment.

回帰分析（Regression Analysis）

- TensorFlow Tutorial (Sherry Moore, Google Brain)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7-Zip File Manager
7-Zip Help
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64-bit ODBC Administrator
Uninstall Amazon Redshift (x64)
Anaconda3 (64-bit)
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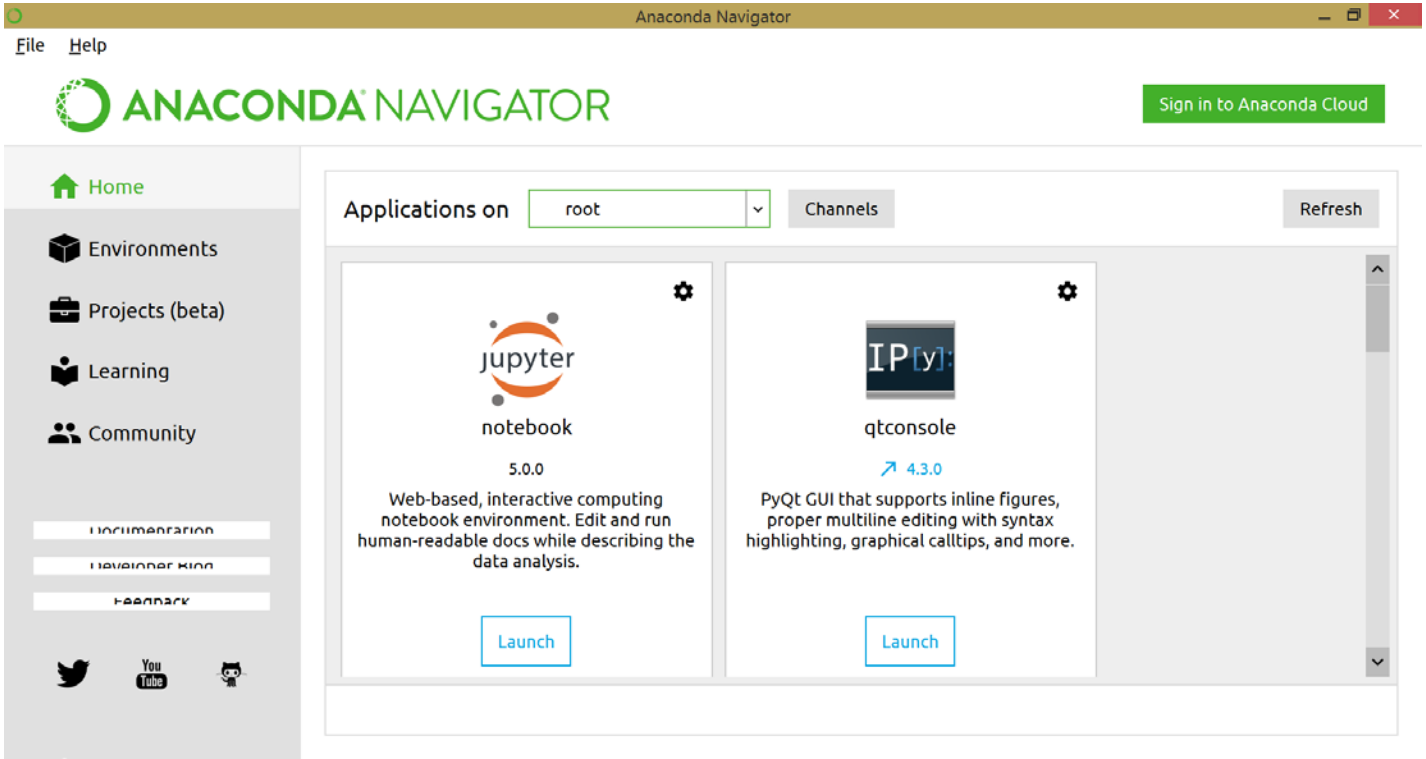
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4.3.0
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.
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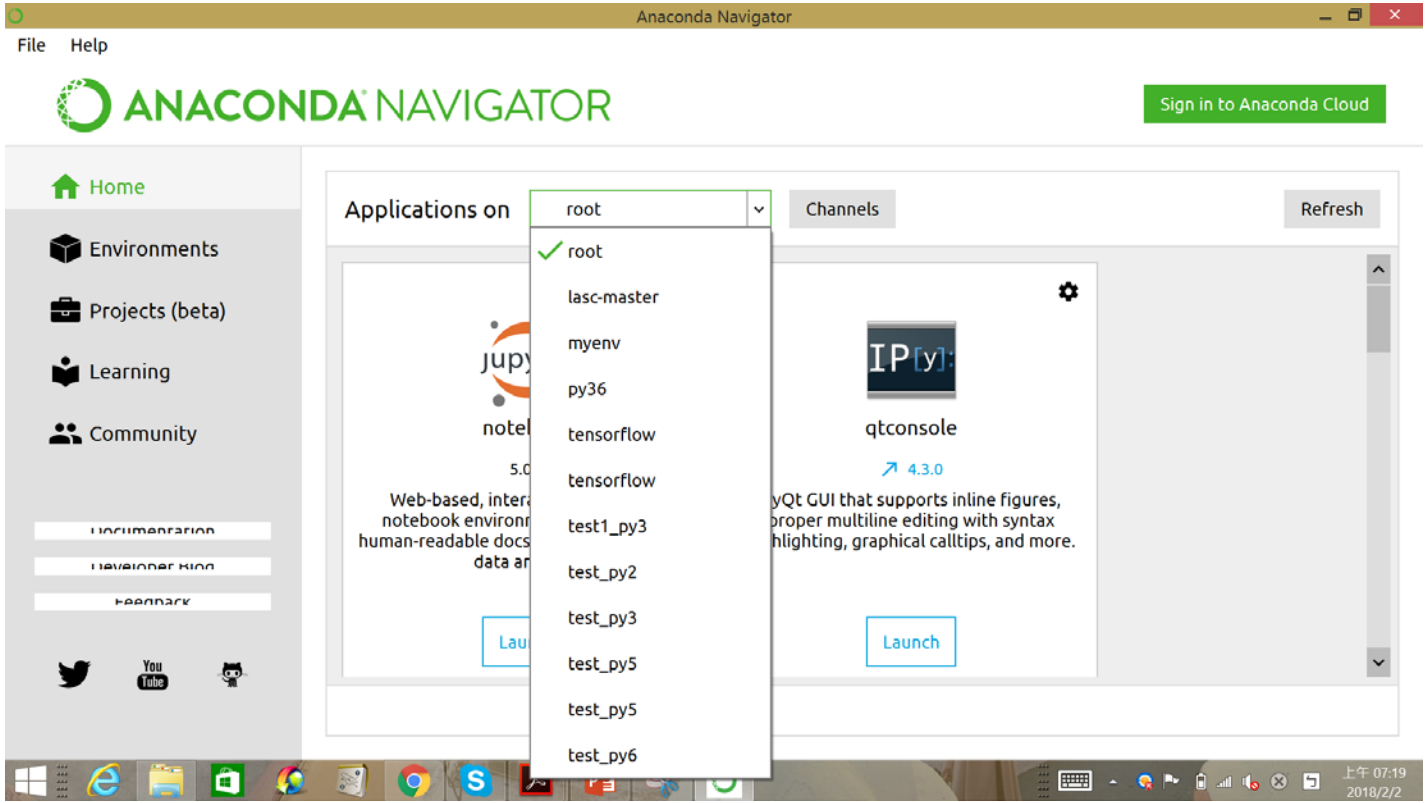
Setting Environment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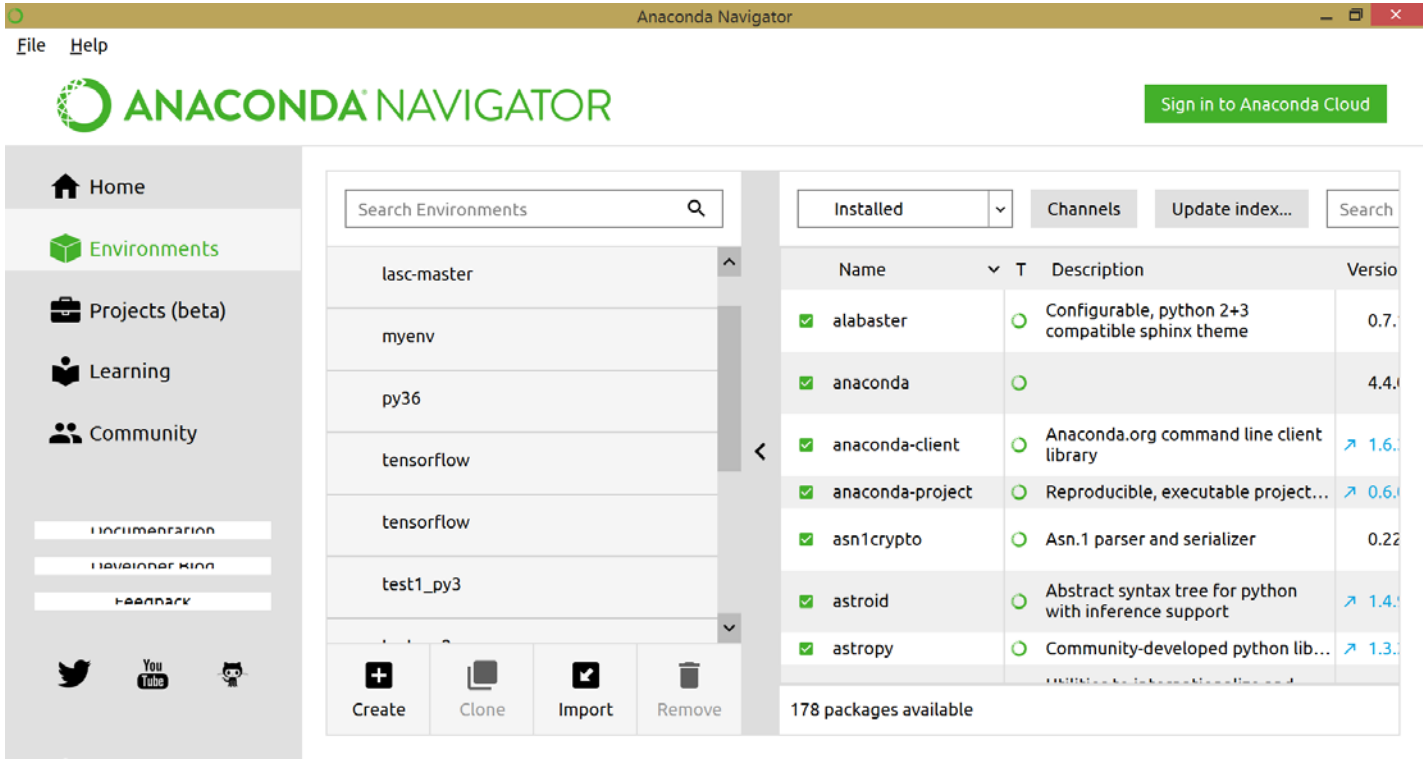
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anaconda-client
Anaconda.org command line client library
anaconda-project
Reproducible, executable project...
asn1crypto
Asn.1 parser and serializer
astroid
Abstract syntax tree for python with inference support
astropy
Community-developed python lib...
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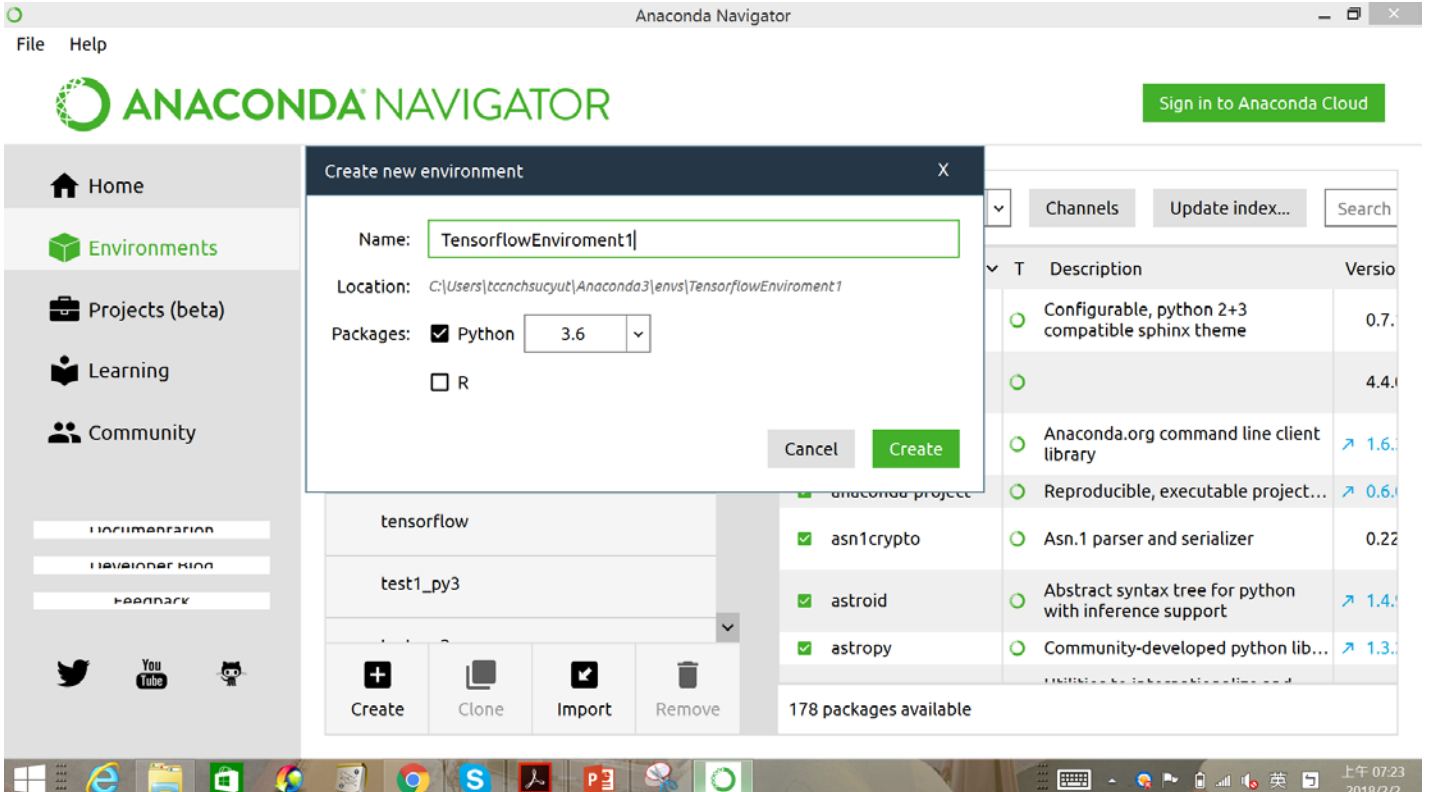
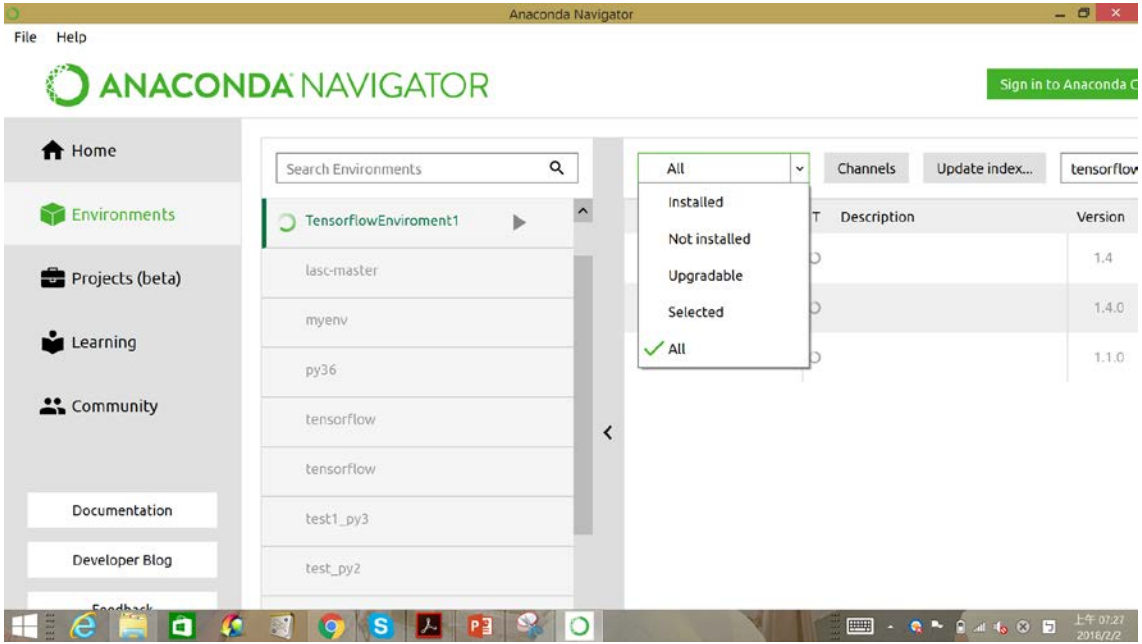
Enviroment->create

- TensorflowEnviroment1



Search->All->Tensorflow



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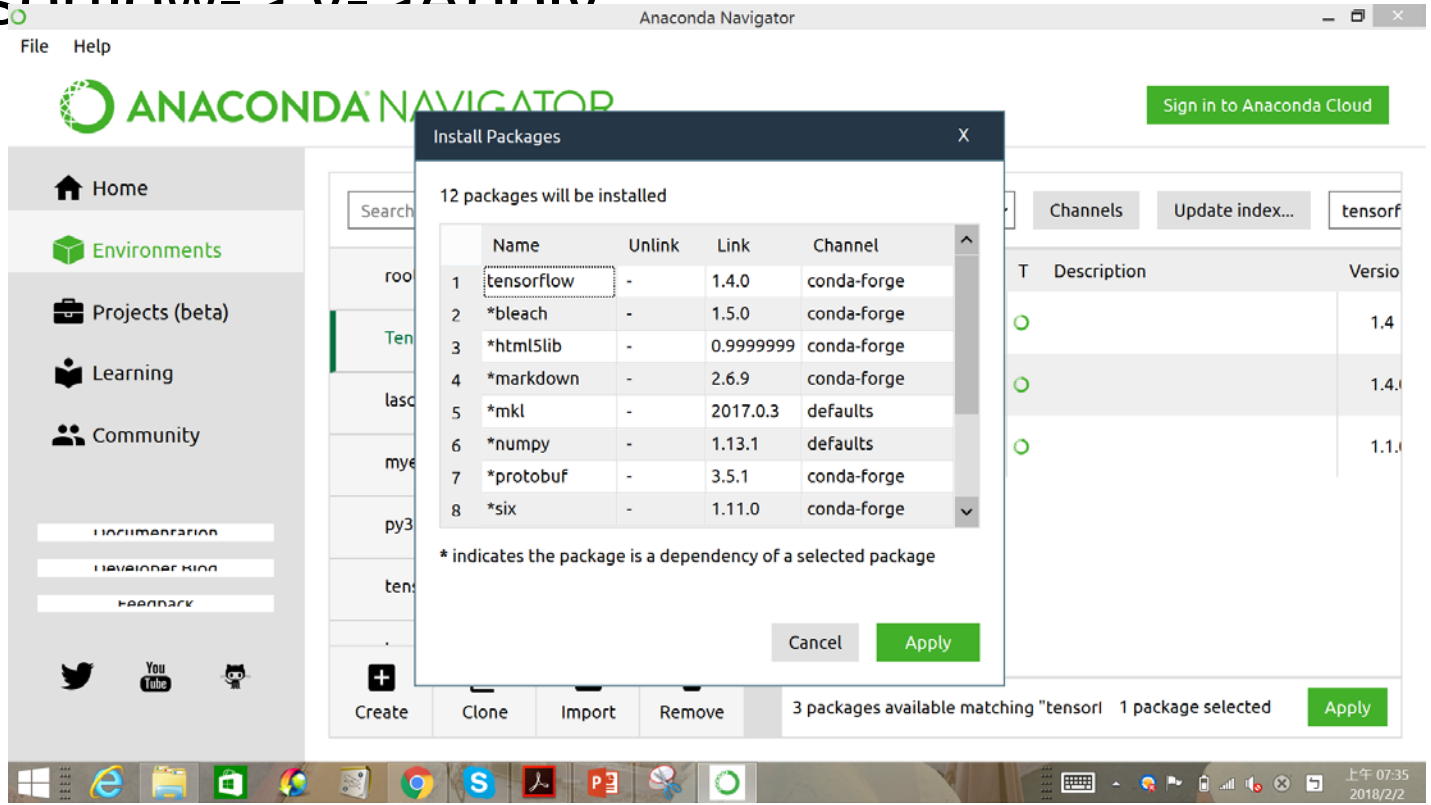

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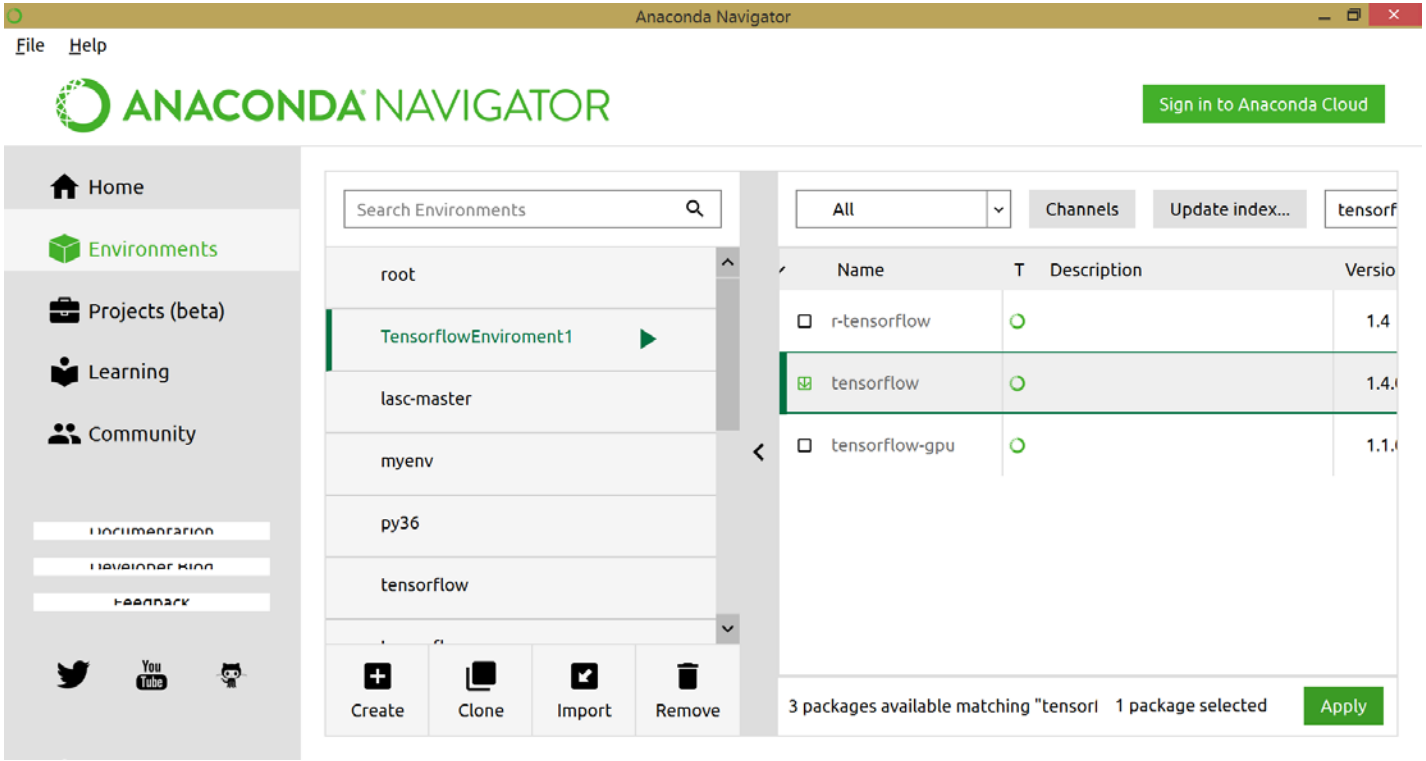

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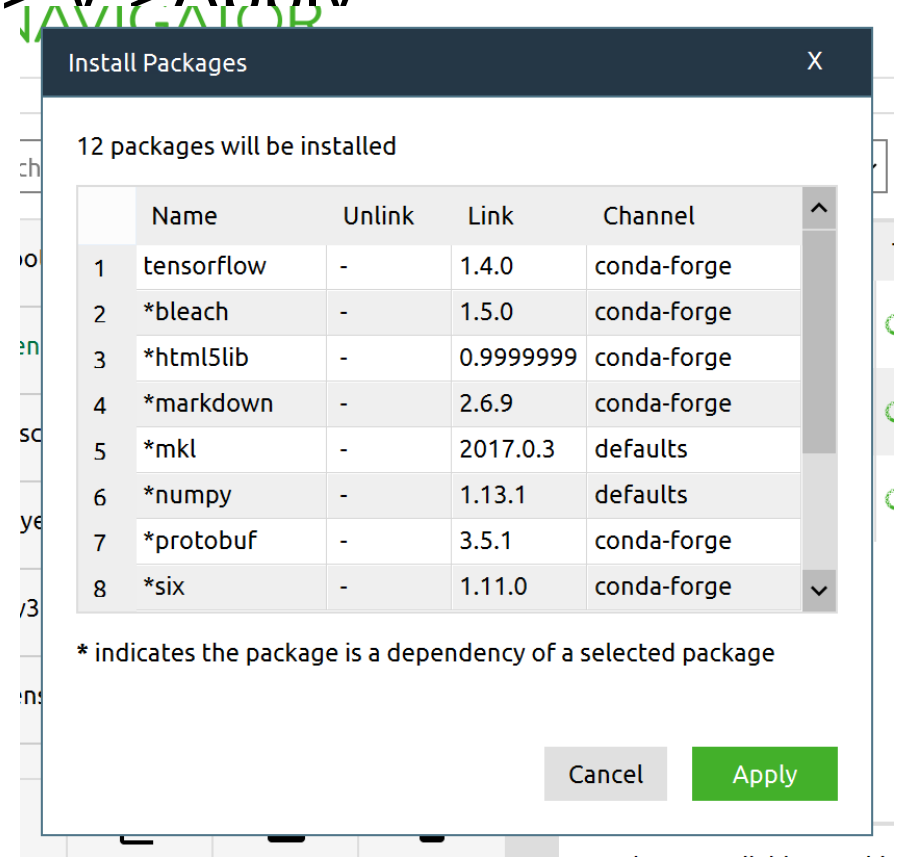

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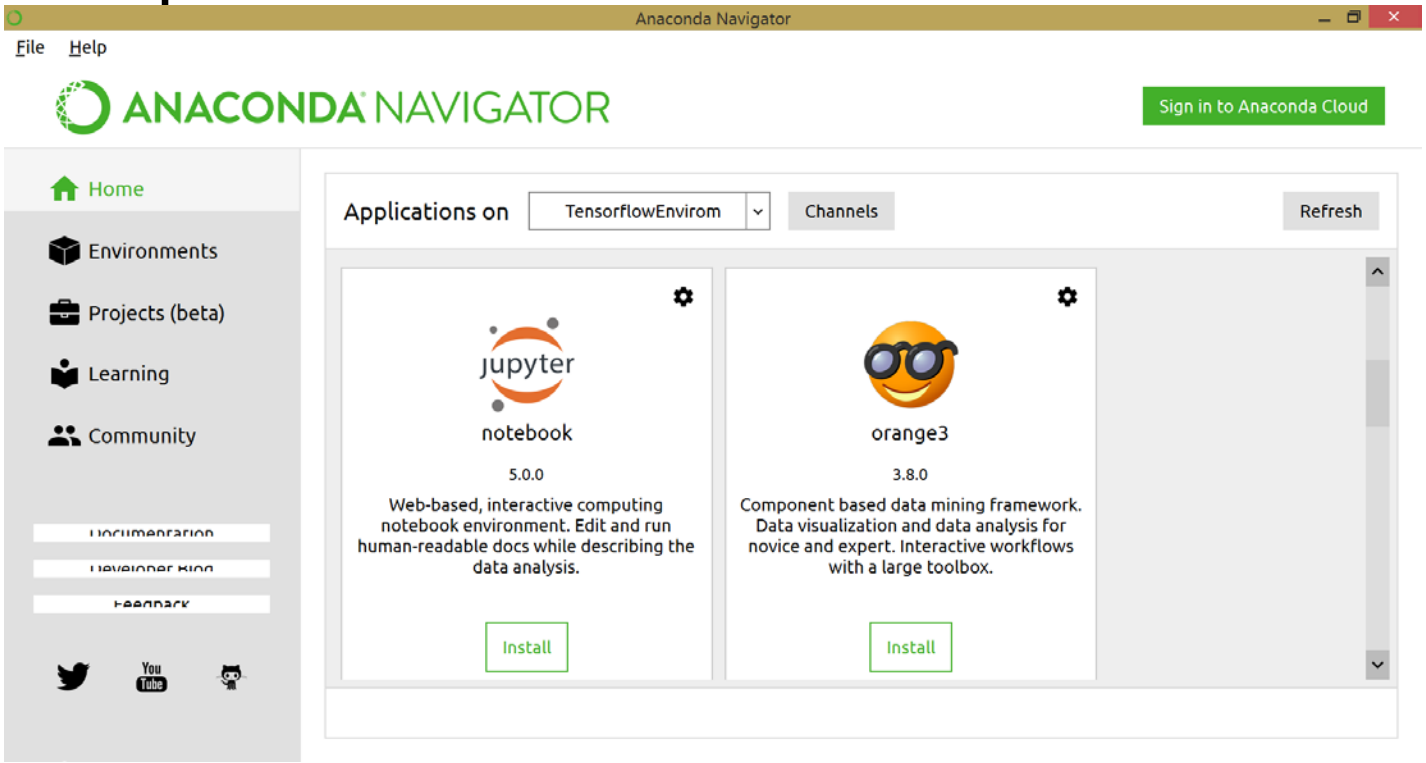

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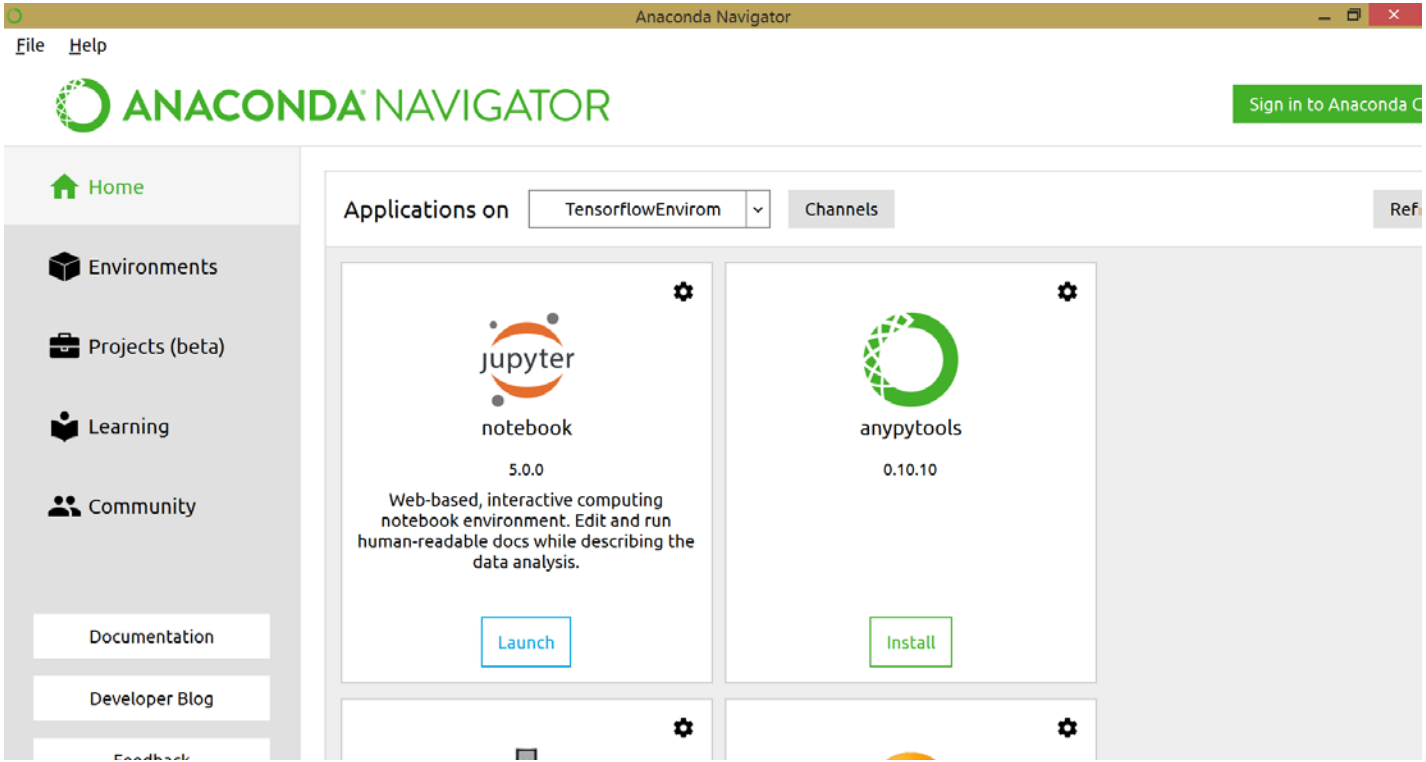

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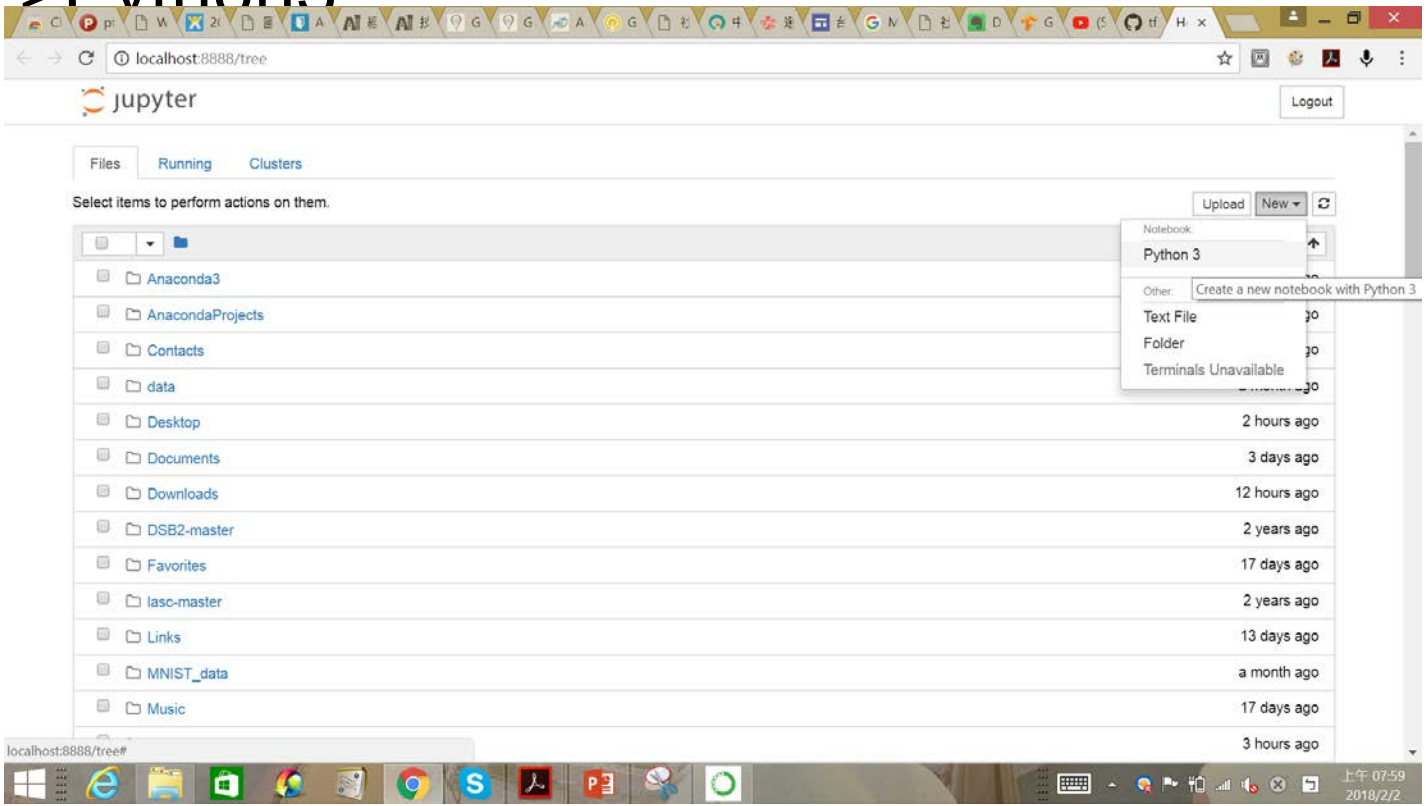
localhost:8888/tree
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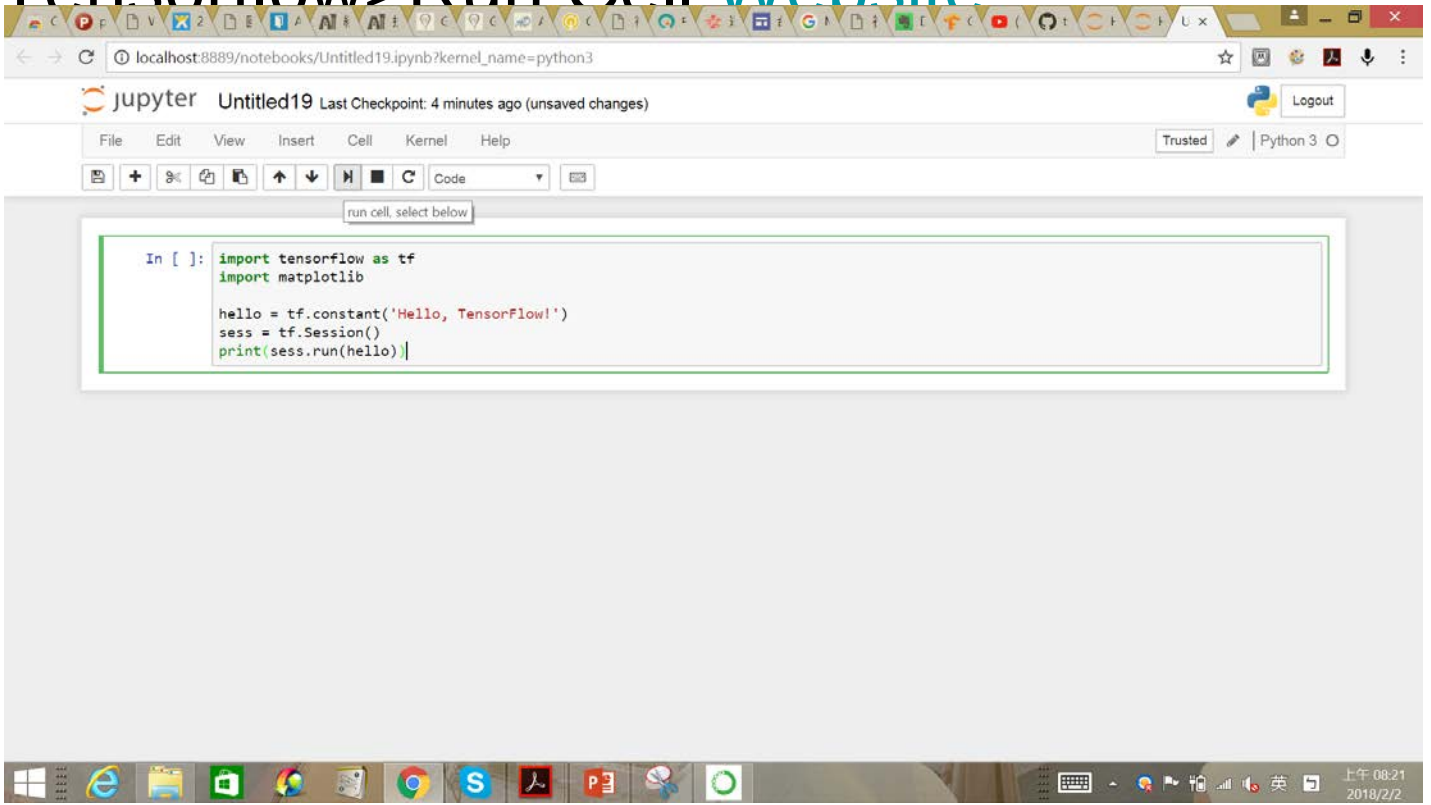
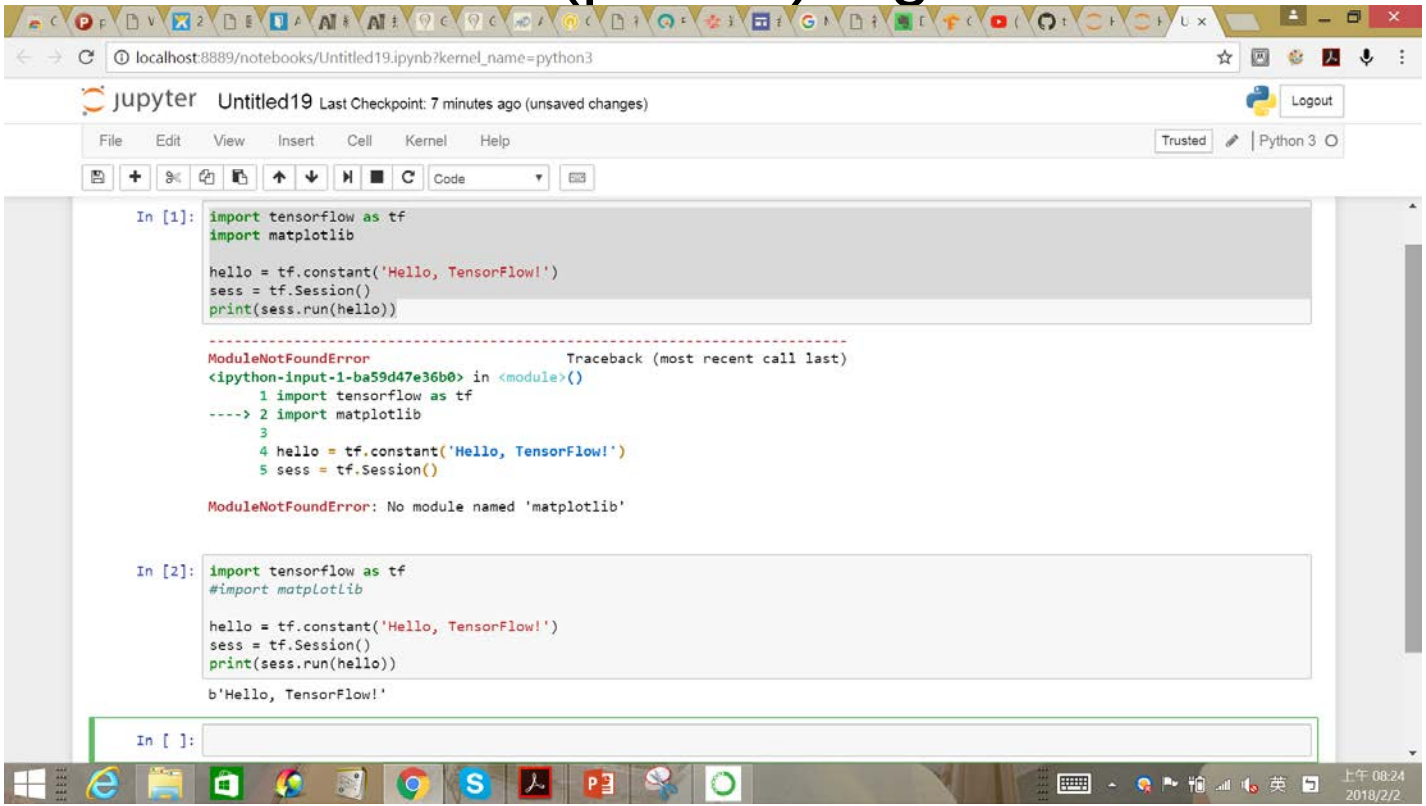
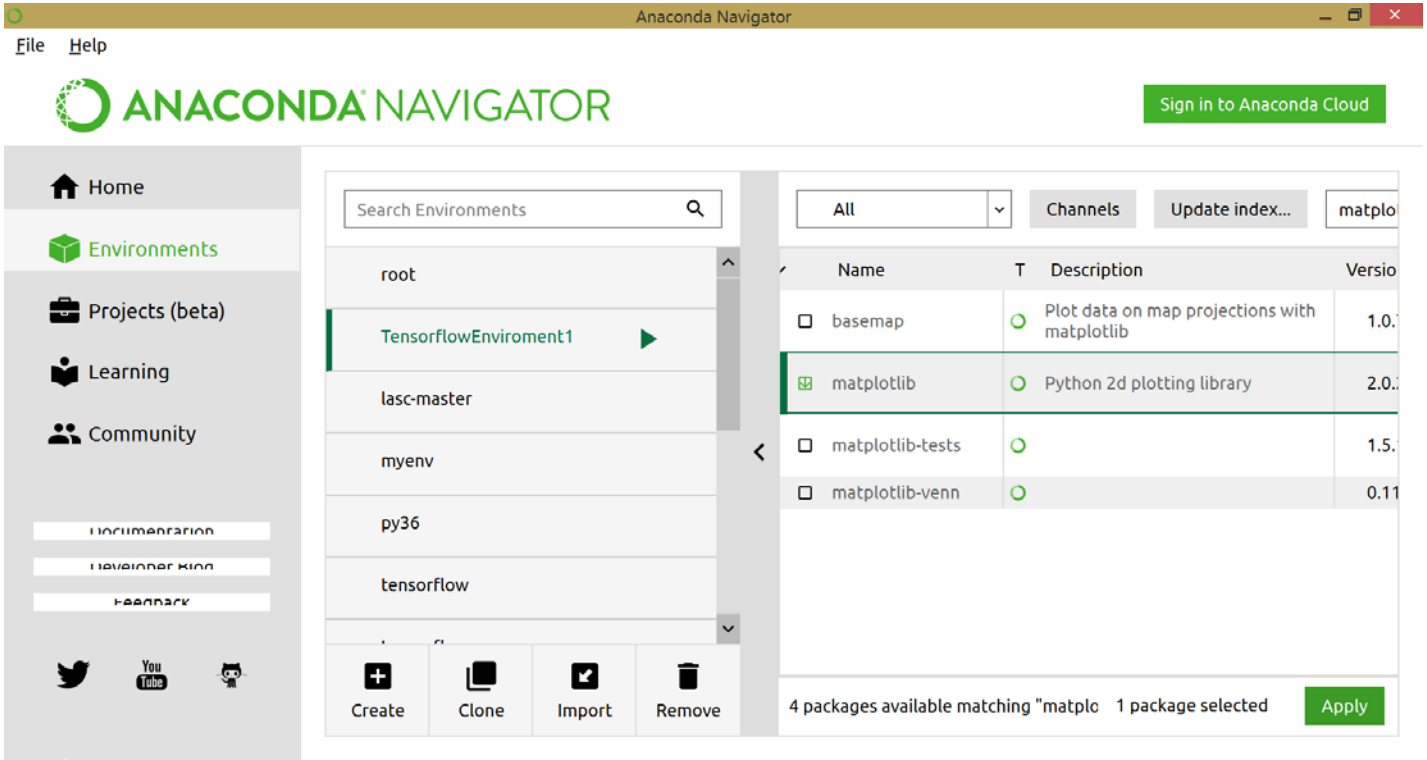
Test Tensorflow>Run Cell Website



Python Comments # (pound) sign

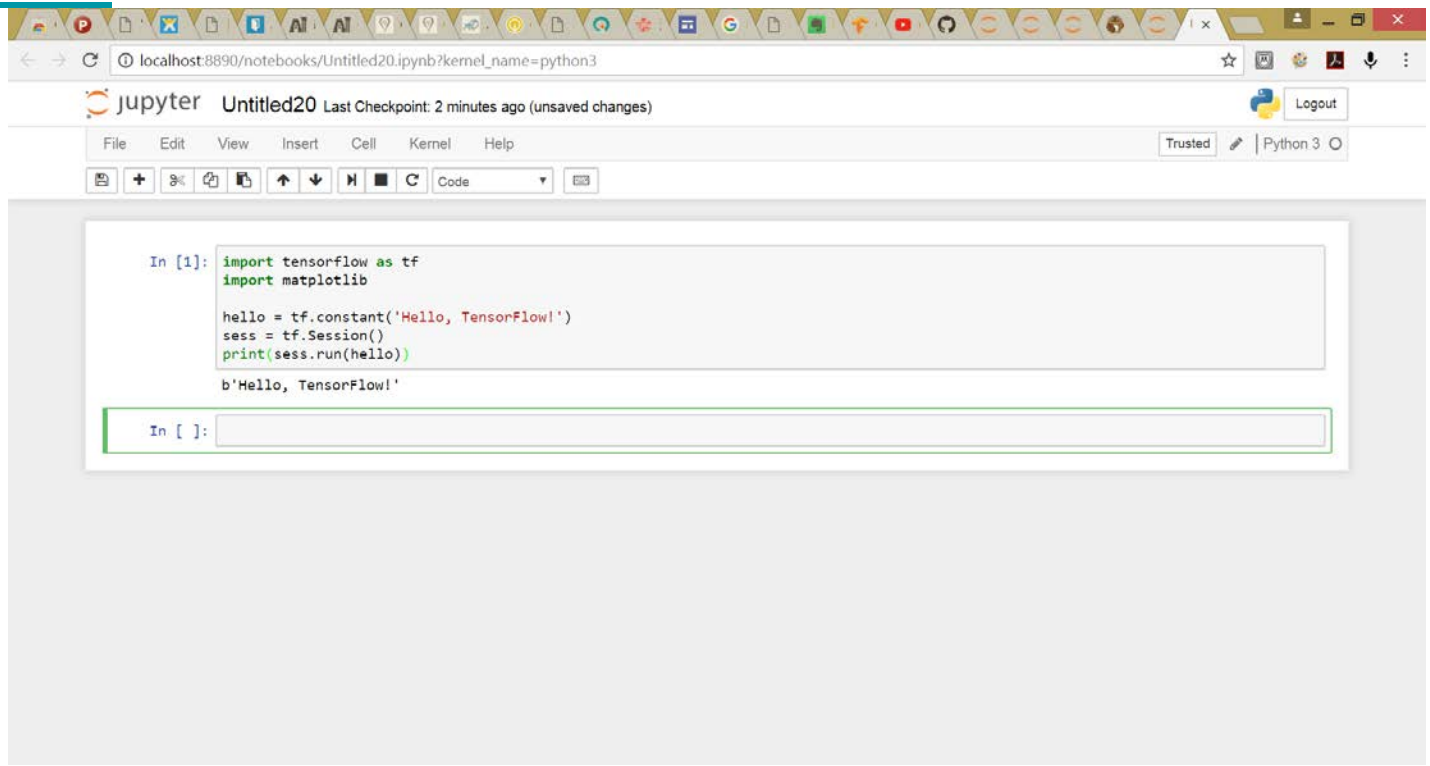


Enviorment->matplotlib->apply



Home->Jupter->Python3

Website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Logout
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Help
Trusted
Python 3
Code
In [1]:
import tensorflow as tf
import matplotlib
hello = tf.constant('Hello, TensorFlow!')
sess = tf.Session()
print(sess.run(hello))
b'Hello, TensorFlow!'
In [ ]:

linear_regression_model.ipynb
web site

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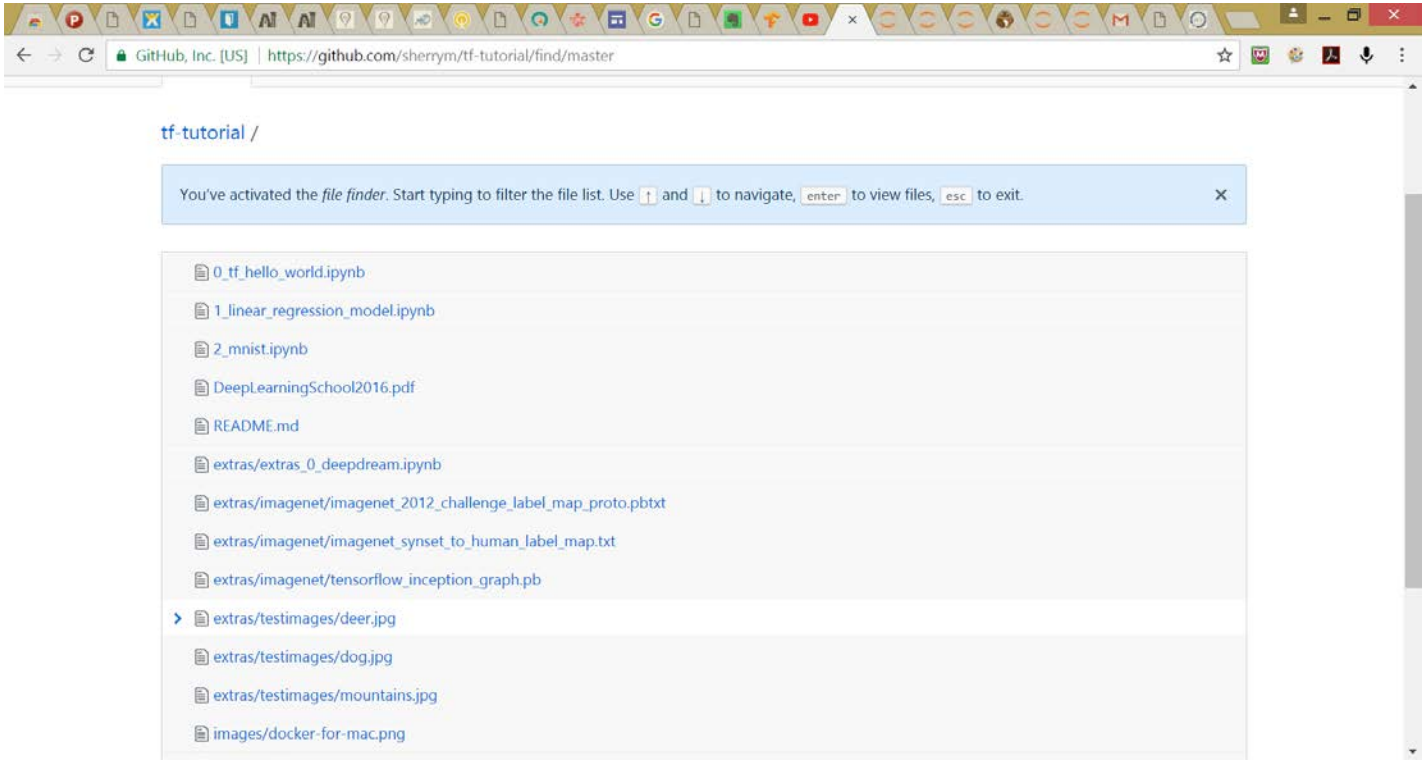
GitHub, Inc. [US] | https://github.com/sherrym/tf-tutorial/find/master
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1_linear_regression_model.ipynb
2_mnist.ipynb
DeepLearningSchool2016.pdf
README.md
extras/extras_0_deepdream.ipynb
extras/imagenet/imagenet_2012_challenge_label_map_proto.pbtxt
extras/imagenet/imagenet_synset_to_human_label_map.txt
extras/imagenet/tensorflow_inception_graph.pb
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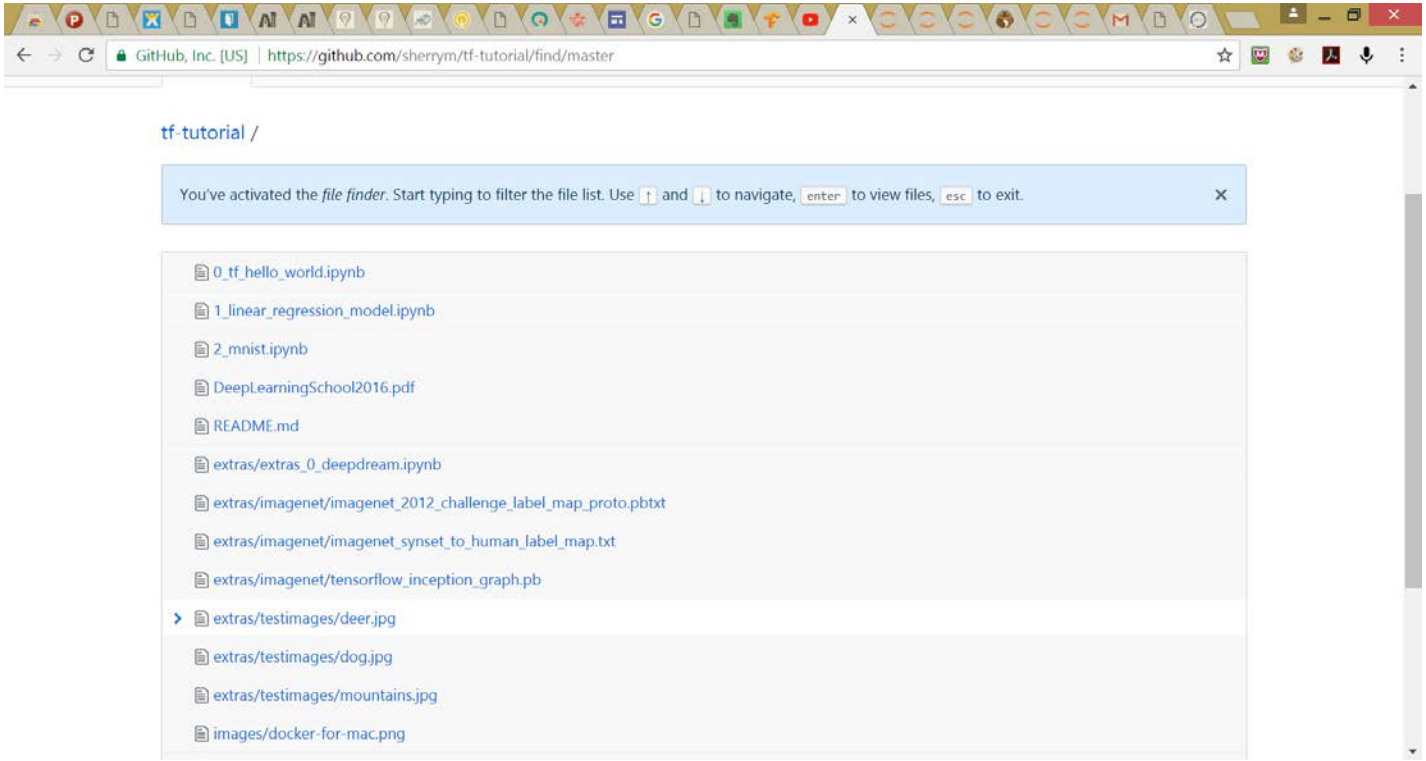

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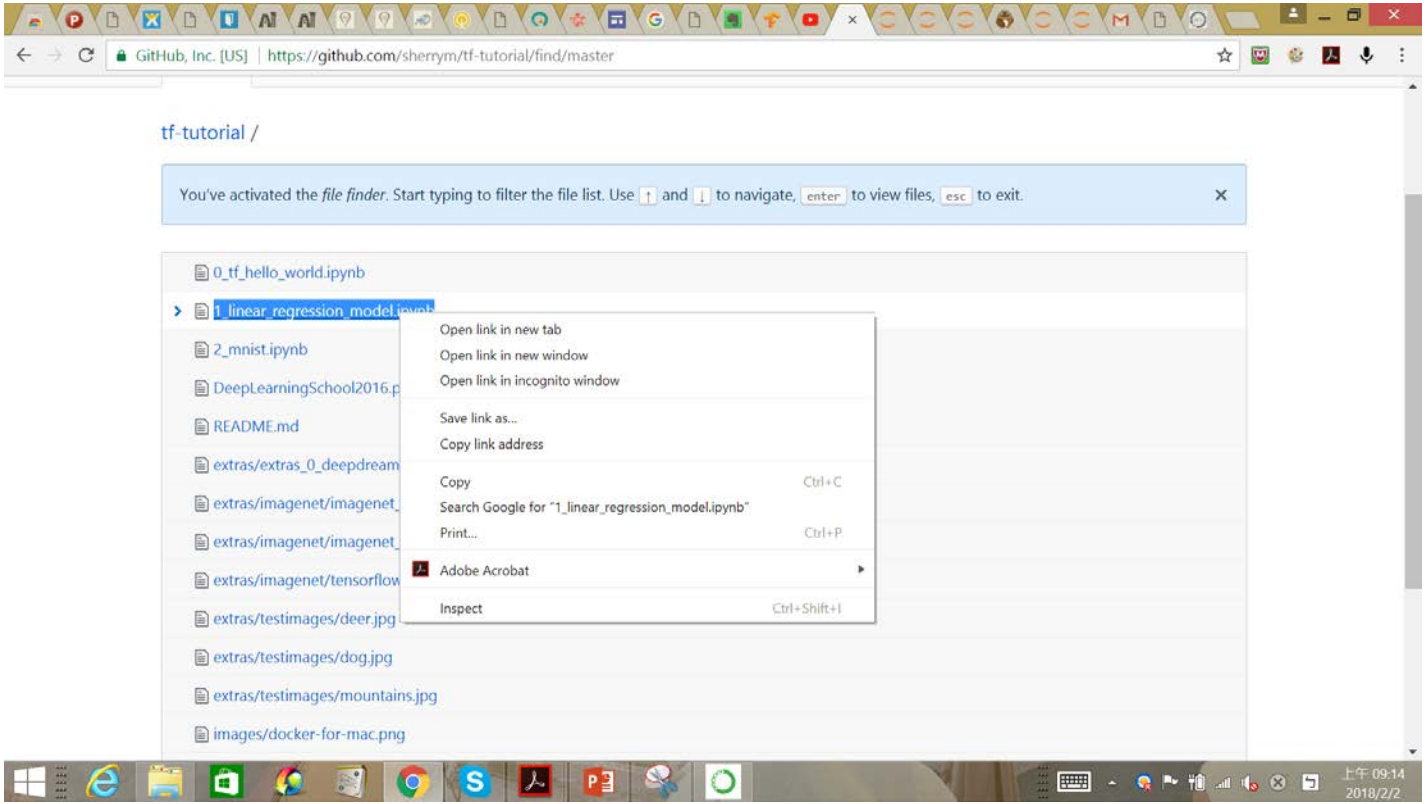
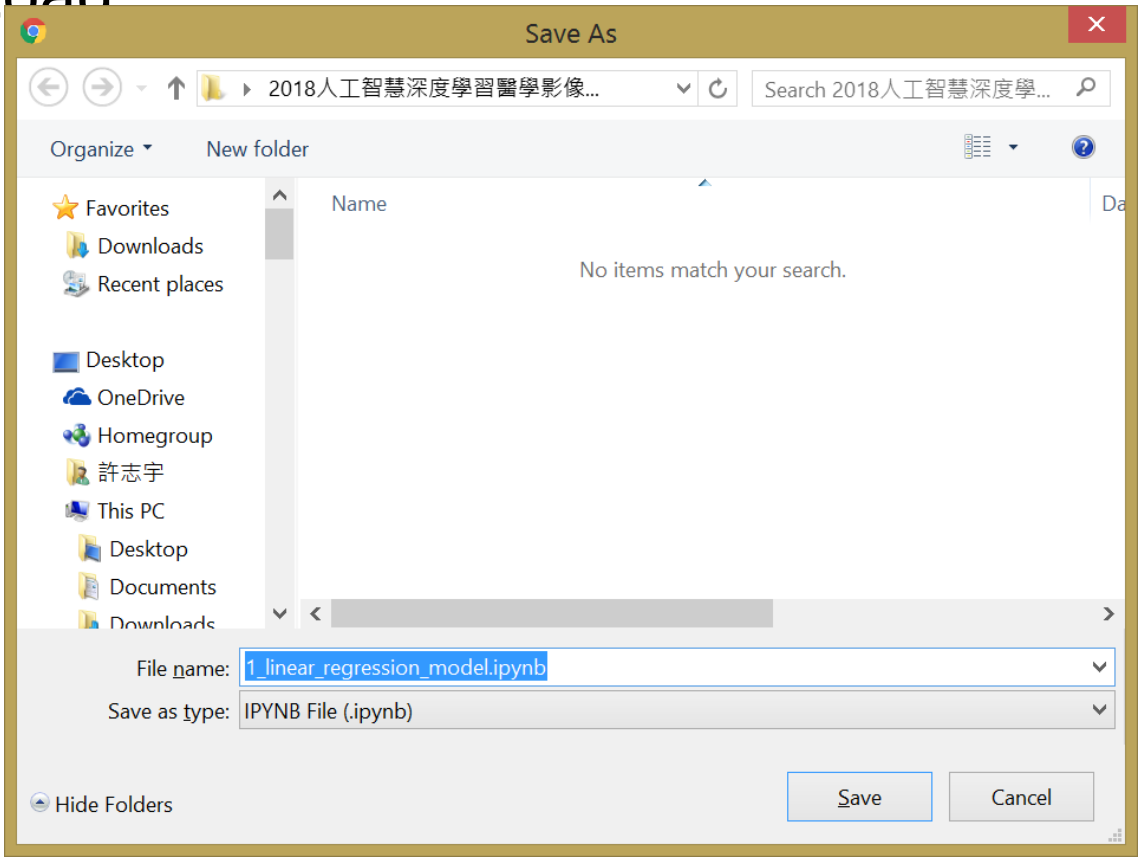


Down Load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1_linear_regression_model.ipynb
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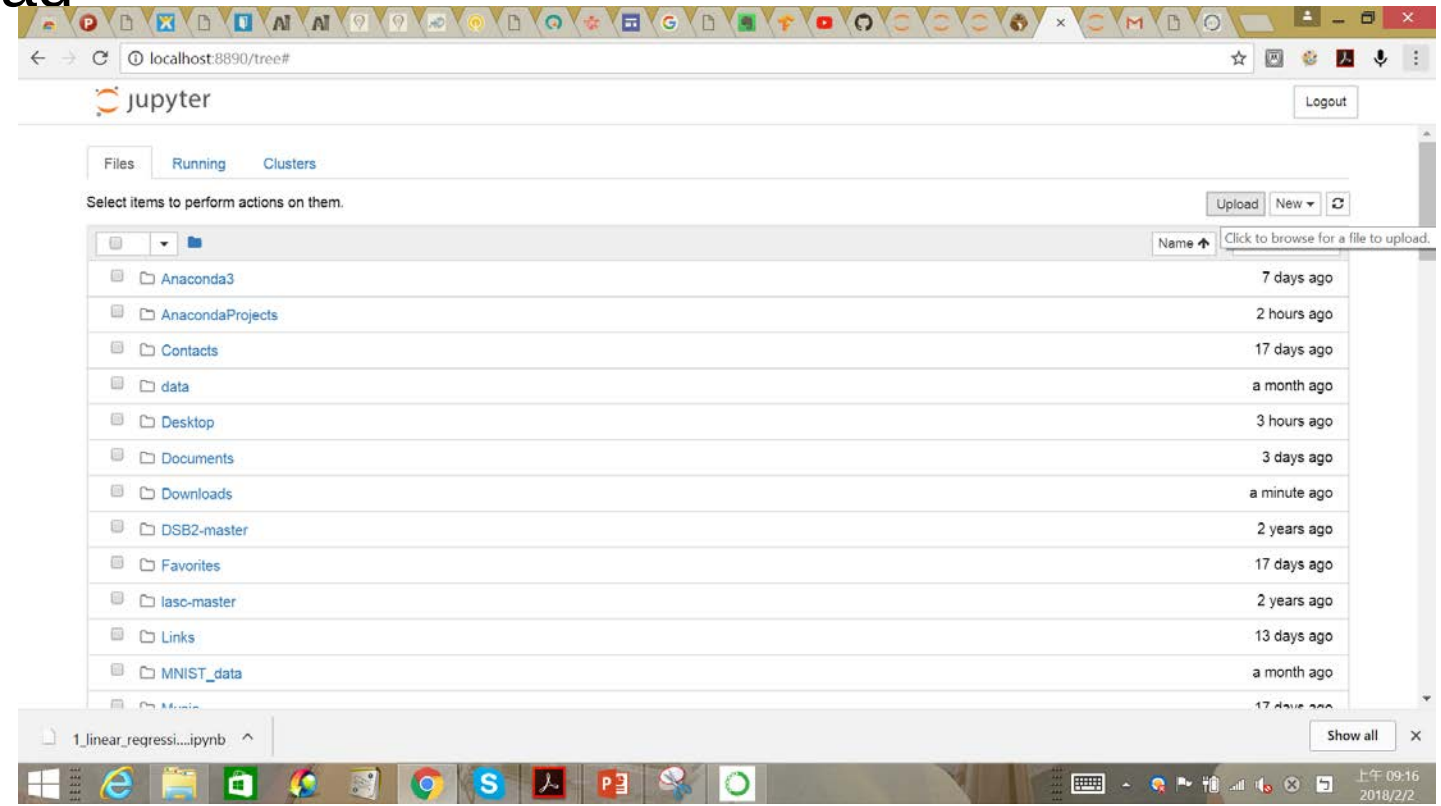
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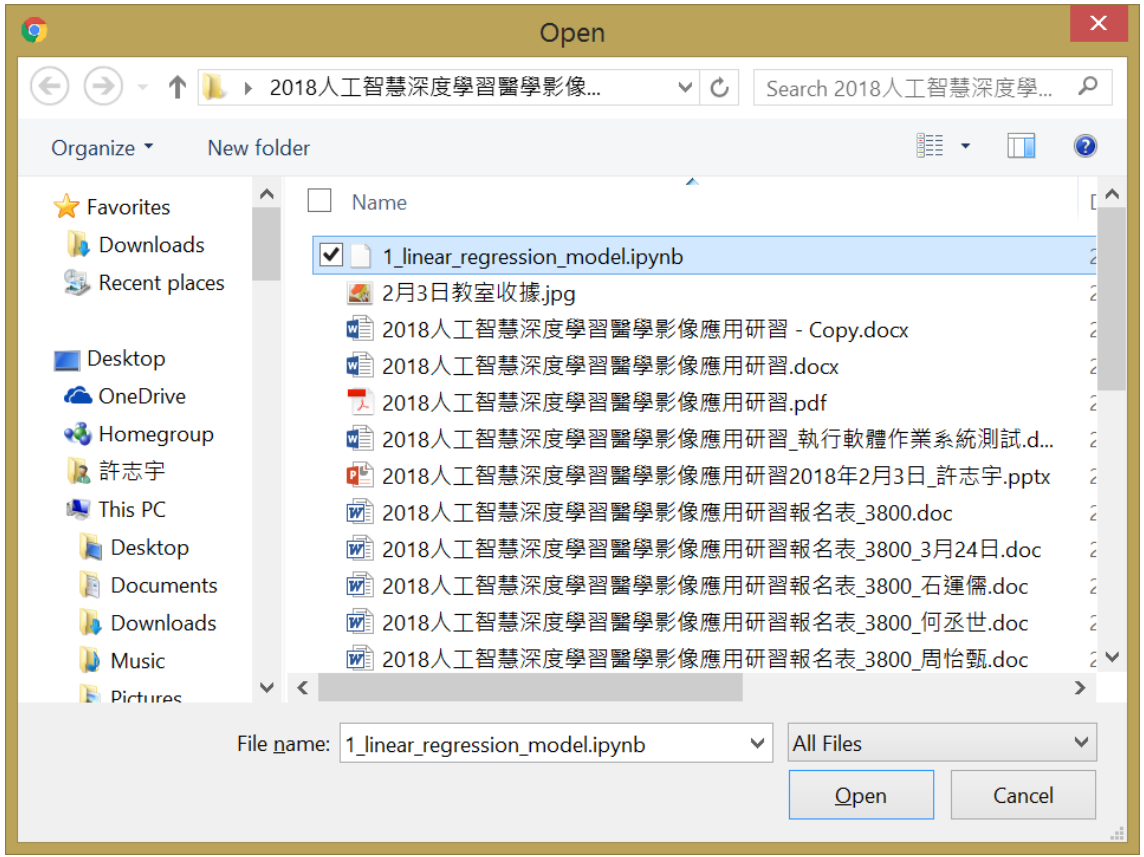
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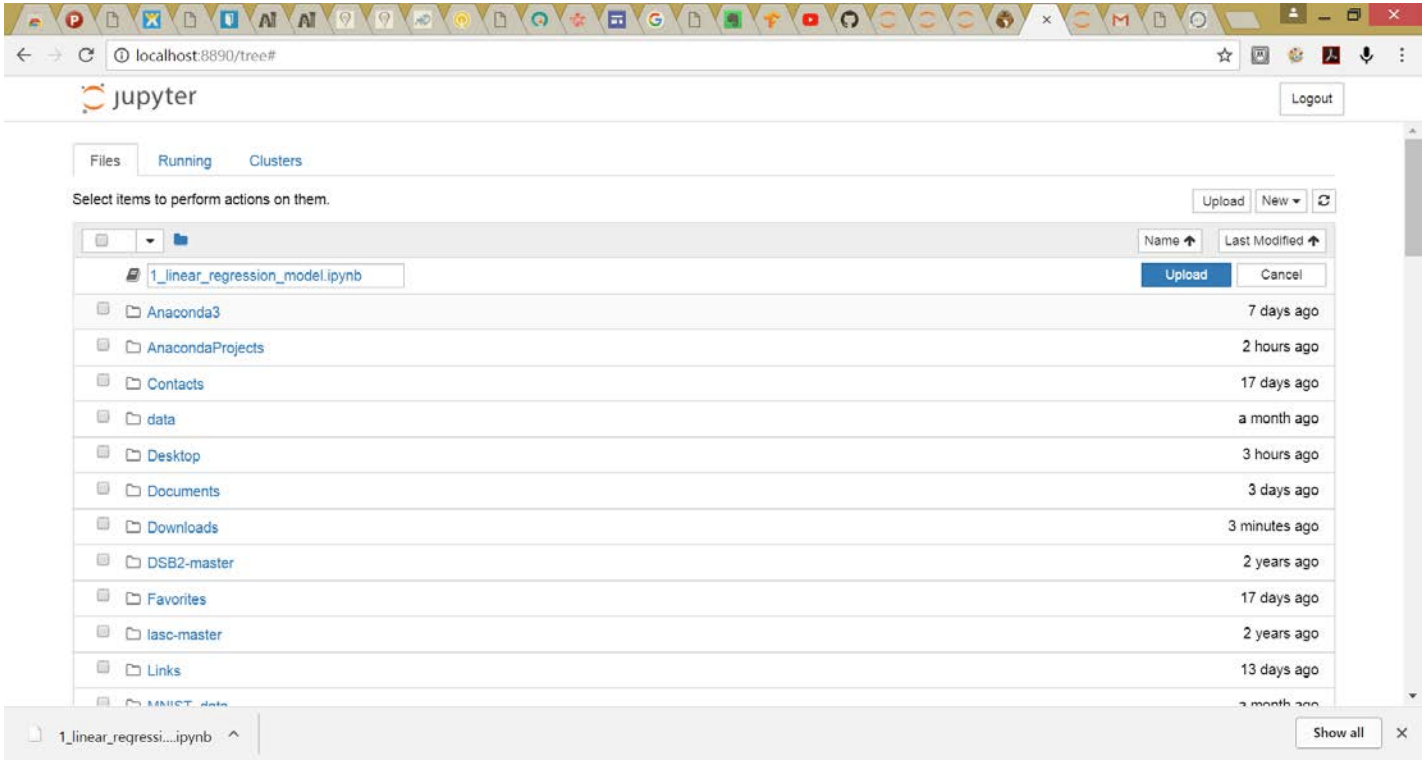
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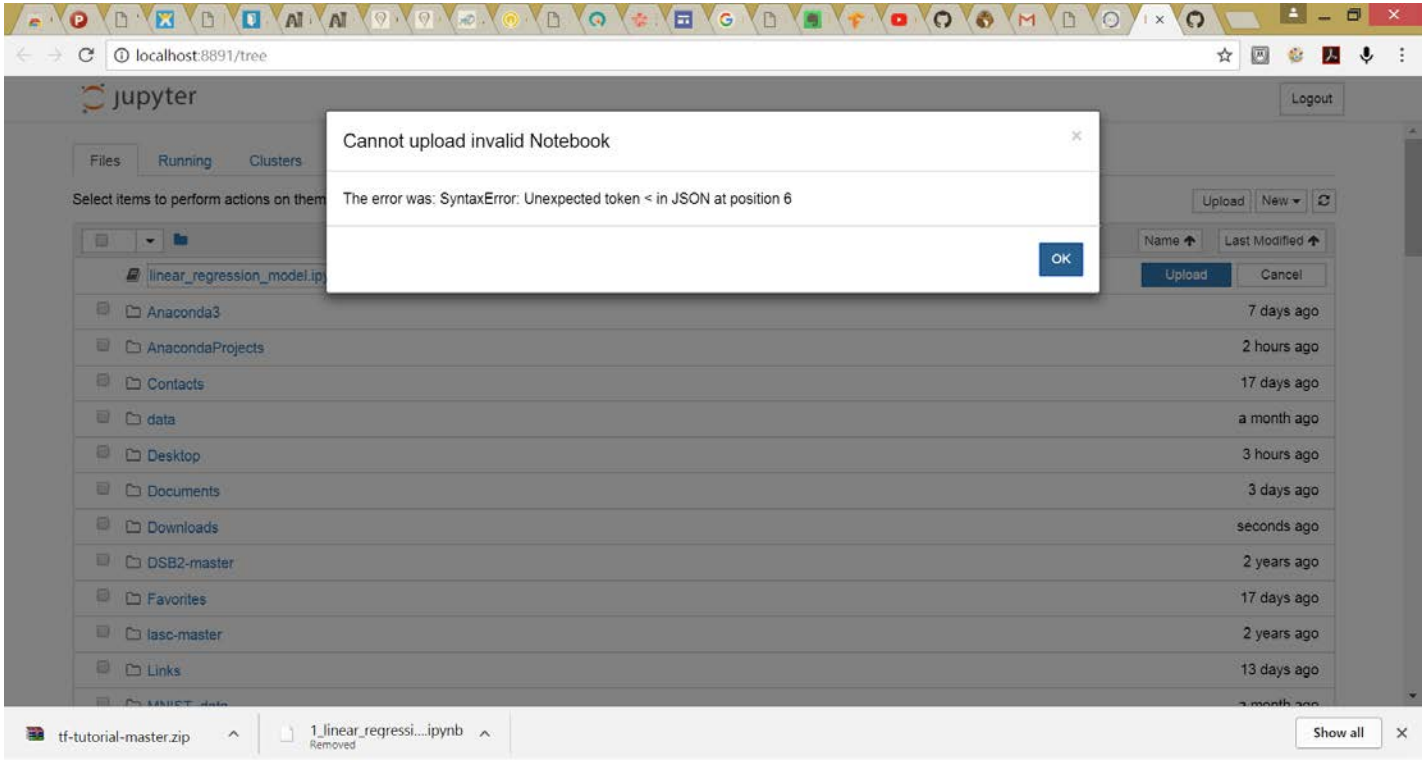
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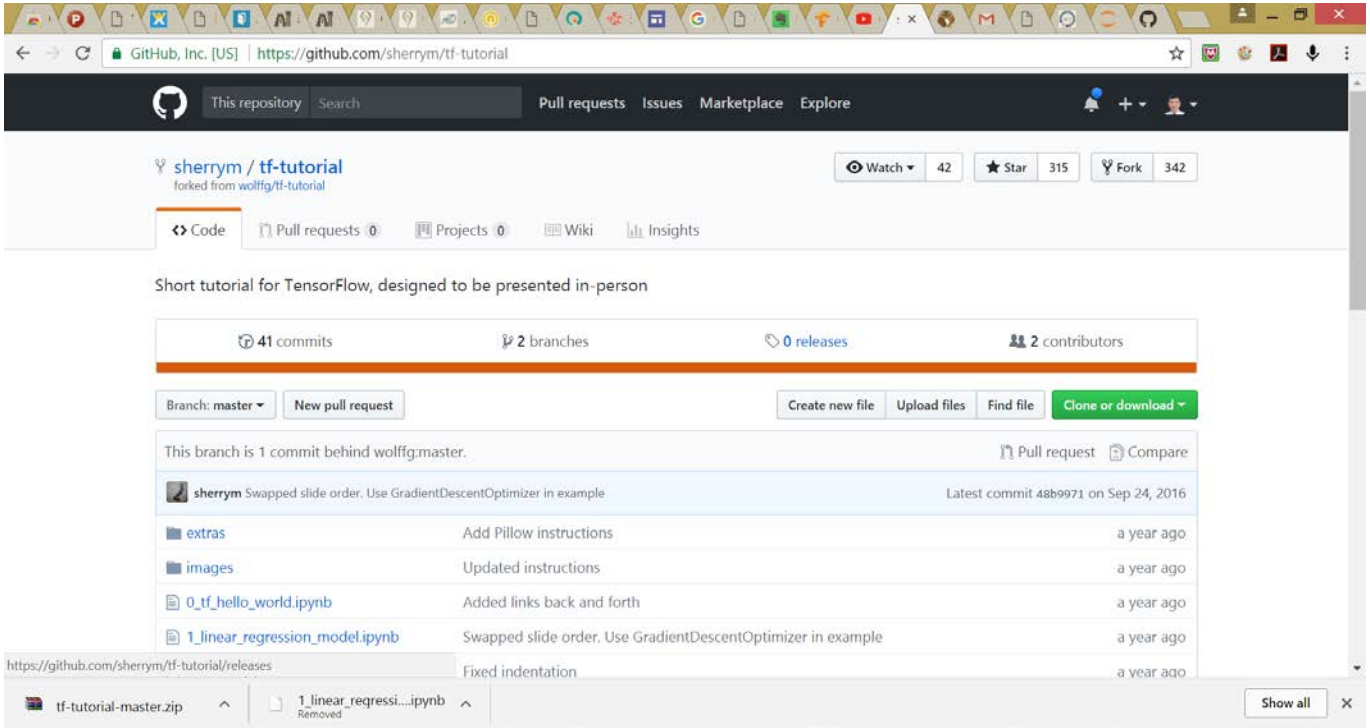

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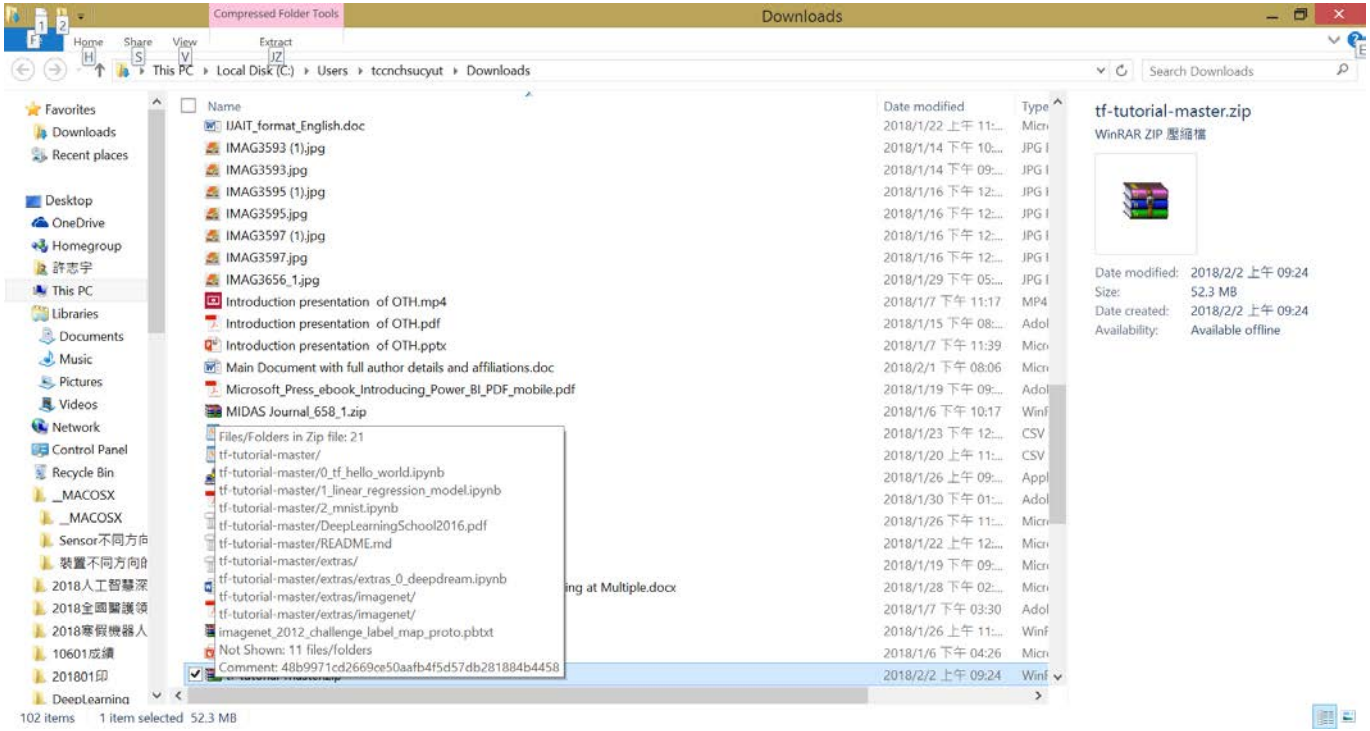

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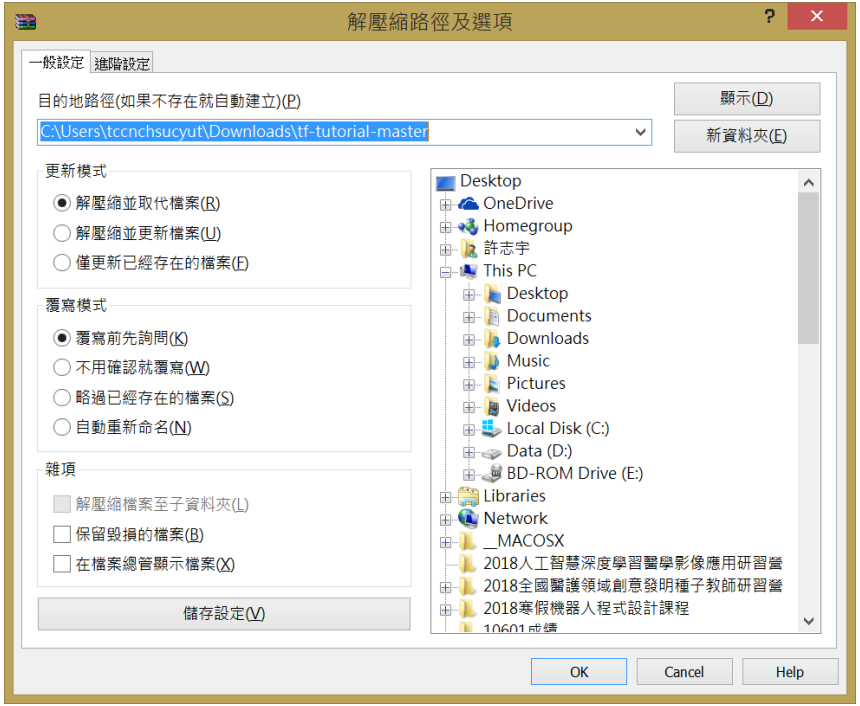

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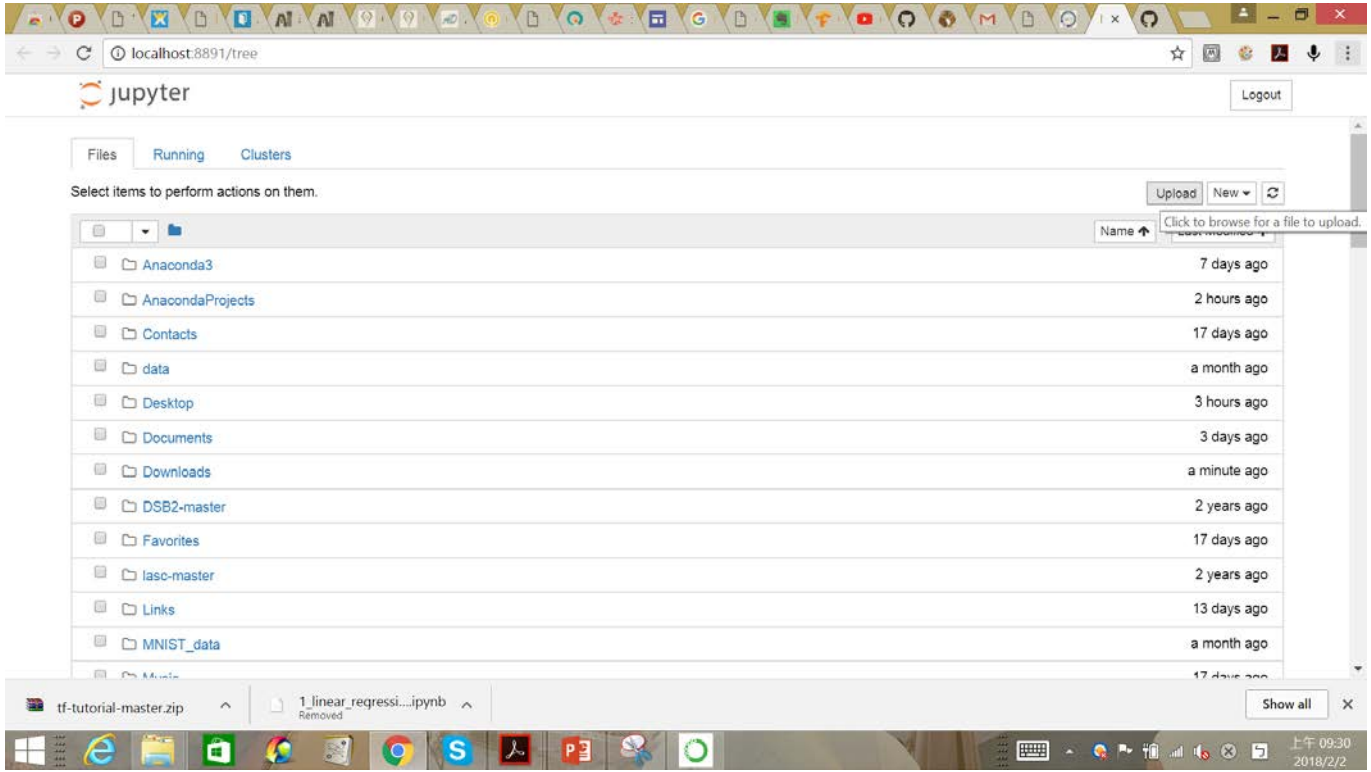
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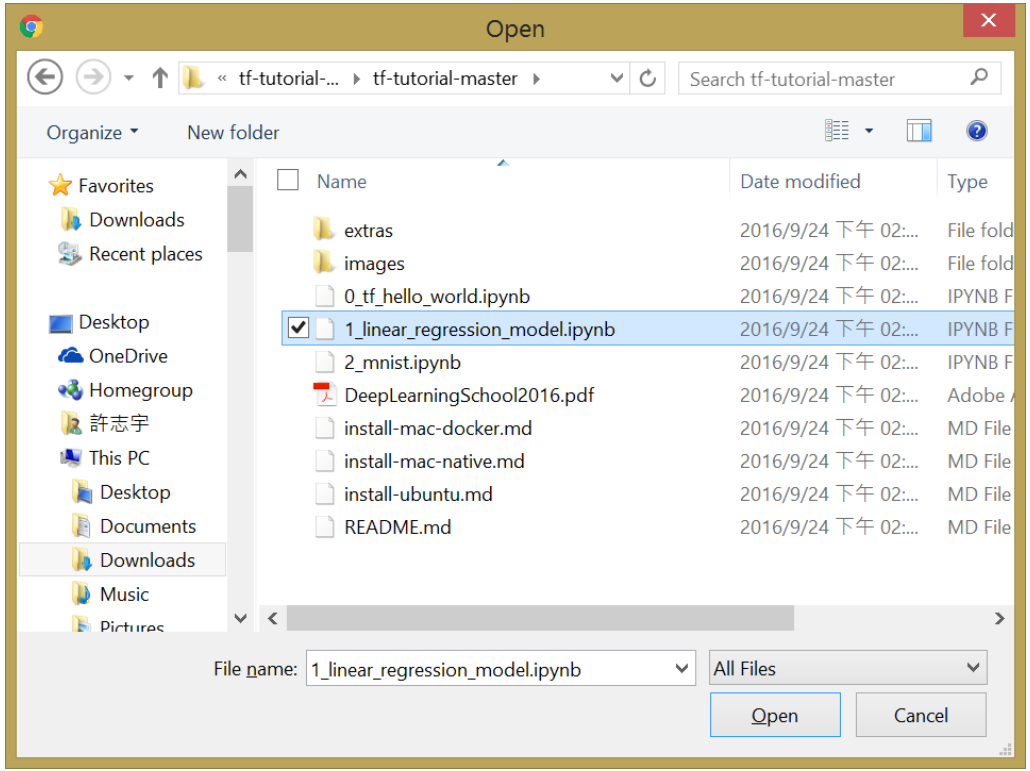
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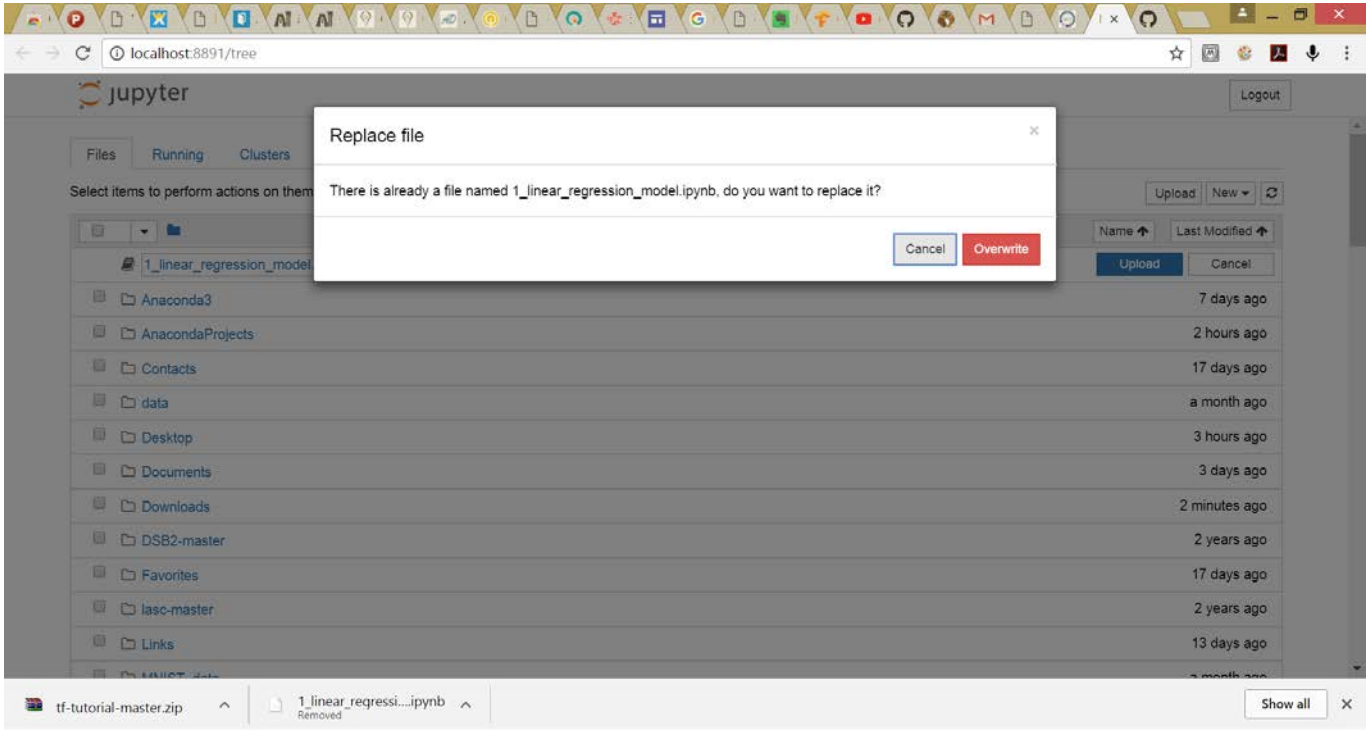
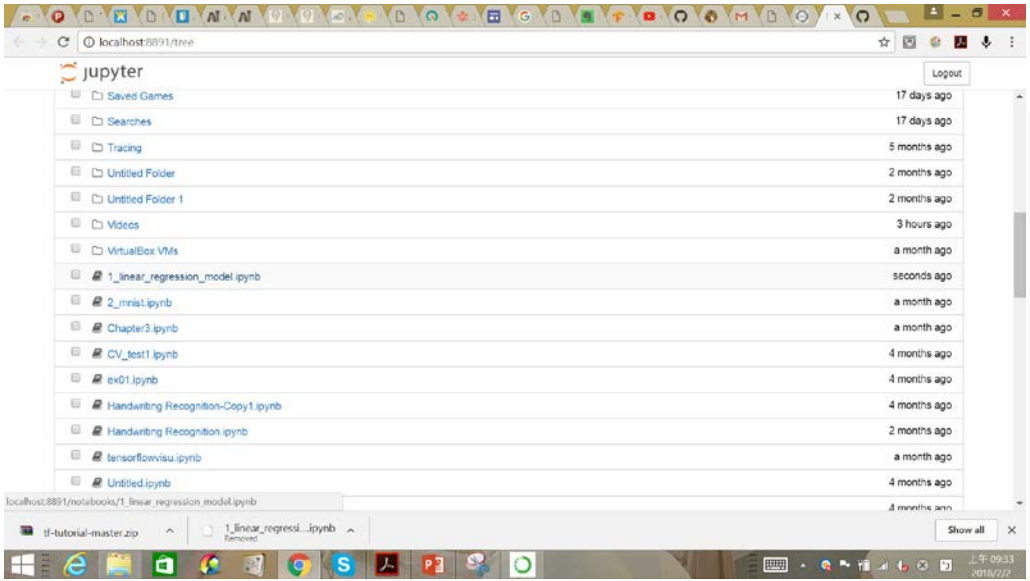
extras
images
0_tf_hello_world.ipynb
1_linear_regression_model.ipynb
2_mnist.ipynb
DeepLearningSchool2016.pdf
install-mac-docker.md
install-mac-native.md
install-ubuntu.md
README.md
File name:
1_linear_regression_model.ipynb
All Files
Open
Cancel

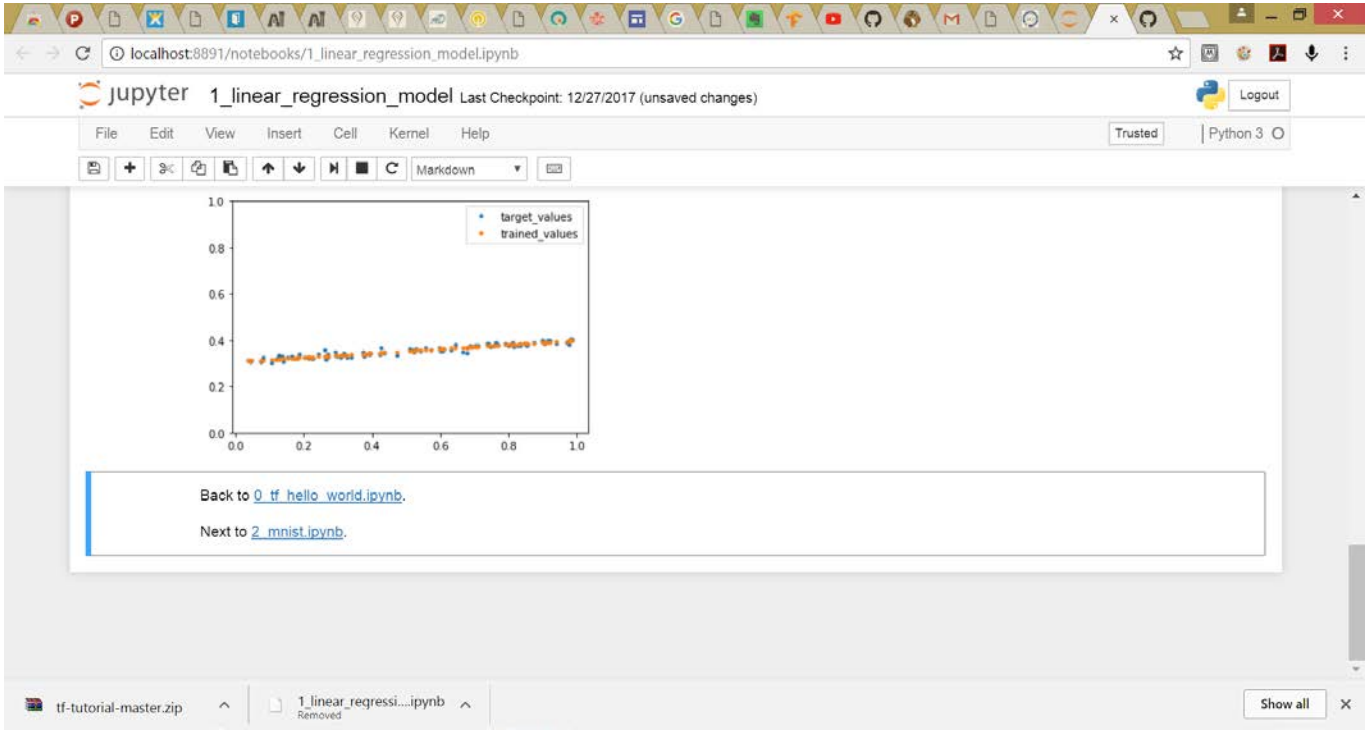
Overwrite


localhost:8891/tree
jupyter
Logout
Files
Running
Clusters
Select items to perform actions on them
Upload
New
Name
Last Modified
1_linear_regression_model
Upload
Cancel
Anaconda3
7 days ago
AnacondaProjects
2 hours ago
Contacts
17 days ago
data
a month ago
Desktop
3 hours ago
Documents
3 days ago
Downloads
2 minutes ago
DSB2-master
2 years ago
Favorites
17 days ago
lasc-master
2 years ago
Links
13 days ago
Replace file
There is already a file named 1_linear_regression_model.ipynb, do you want to replace it?
Cancel
Overwrite
tf-tutorial-master.zip
1_linear_regressi....ipynb
Removed
Show all

Open 1_linear_regression_model.ipynb



Run Cell


localhost:8891/notebooks/1_linear_regression_model.ipynb
jupyter
1_linear_regression_model
Last Checkpoint: 12/27/2017 (unsaved changes)
Logout
File
Edit
View
Insert
Cell
Kernel
Help
Trusted
Python 3
Markdown
target_values
trained_values
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
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1.0
Back to 0_tf_hello_world.ipynb.
Next to 2_mnist.ipynb.
tf-tutorial-master.zip
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Show all

Regression Analysis

- How can we obtain a two dimensional line equation by given three points (x1,y1), (x2,y2) and (x3,y3)?A line can pass through only two points.

Regression Analysis

- There is no distance between a point and a line if the point is on the line.
- If three points are on the line y=m*x+b.
  y1=mx1+b
  y2=mx2+b
  y3=mx3+b
- On the other hand, there is some distance between a point and a line if the point is not on the line.
- How can we define the distance to easily obtain the optimal parameters m and b

Regression Analysis

- How can we define the object function to easily obtain the optimal parameters m and b without the definition of distance between a point and a line?
- This is a liner regression model problem.
- We do not use the definition of a distance between a point and a line.
- Instead of using distances between points and a line we use square errors defined by (y1-f(x1))**2, (y2-f(x2))**2 and (y3-f(x3))**2.

Regression Analysis

- The linear regression model problem is transformed to a optimal problem with a object function that is the sum of the square errors.
- The optimal parameters m and b are obtained as the object function is minimum.

Regression Analysis

- Partial derivatives of the error function respect to parameters m and b are named as a gradient vector and it is equal to a zero vector where critical points is located.
- We can obtain a vector equation.
- Gradient(sum of error function (m,b))=(0,0)The architecture of deep neural network(nn) is as follow,

What is a Model?

- A Model is a mathematic function with parameters and inputs and outputs.

What are the parameters for linear equations?

- For example, a linear equation.
- y=m*x+b of a line in two dimensional coordinate
- the slope m and intercept b are parameters.

A model is a function

- If we define a function
  $f(x)=mx+b$ and $y=f(x)$
  x is input and y=output.

Parameters

- We can obtain any line by setting the parameters m and b.

What is learning?

- Unsupervised Learning
  - Machine can automatically choose the parameters by data set.
- Supervised Learning
  - Machine can automatically choose the parameters by data set and Labels.

What is learning?

- For example, how could we decide a two dimensional line equation by given two points(x1,y1) and (x2,y2)?
- Two points give one data set

What is learning?

- We substitute two pair coordinates into the equation
- y=mx+b to solve the simultaneous linear equations to obtain parameters m and b.

y1=m*x1+b

y2=m*x2+b

- These two equations can be used to derive the parameters m and b.

m=(y2-y1)/(x2-x1)

b=y1-(y2-y1)/(x2-x1)*x1

- We can compute m and b by above two formulas.
- Analytic Solution or Close form of parameters

What is learning?

- Could we obtain parameters m and b automatically by machine?
- Define Function f(x)=mx+b

f(x1)=m*x1+b

f(x2)=m*x2+b

- The data set are (x1,y1) and (x2,x2)
- The square error between f(x1) and y1 is defined as (f(x1)-y1)**2
- The square error between f(x2) and y2 is defined as (f(x2)-y2)**2
- The sum of square function is defined as
- SumErrors(m,b)=(m*x1+b-y1)**2+(m*x2+b-y2)**2

What is learning?

- Take partial deferential operation on SumErrors(m,b) respect to m. (Chain Rule)
- 2(m*x1+b-y1)*x1+ 2(m*x2+b-y2)*x2
- Take partial deferential operation on SumErrors(m,b) respect to b.) (Chain Rule)
- 2(m*x1+b-y1)+ 2(m*x2+b-y2)
- For finding optimum, we have to set them to zero .
- 2(m*x1+b-y1)*x1+ 2(m*x2+b-y2)*x2=0
- 2(m*x1+b-y1)+ 2(m*x2+b-y2)=0

What is learning?

- 2(m*x1+b-y1)*x1+ 2(m*x2+b-y2)*x2=0
- 2(m*x1+b-y1)+ 2(m*x2+b-y2)=0
- Transform
- 2(m*x2+b-y2)*(x2-x1)=0
- 2(m*x1+b-y1)*(x1-x2)=0
- Transform
- mx2+b-y2=0=>y2=mx2+b
- mx1+b-y1=0=>y1=mx1+b
- These two equations can be used to derive the parameters m and b.

m=(y2-y1)/(x2-x1)

b=y1-(y2-y1)/(x2-x1)*x1

- We can compute m and b by above two formulas.
- Analytic Solution or Close form of parameters

What is learning?

- How can we obtain a two dimensional line equation by given three points (x1,y1), (x2,y2) and (x3,y3)?
- Could we obtain analytic solutions of parameters m and b in Close form.
- Could we can compute m and b by two formulas?
- Yes or No, home work1!
- Home work2, repeat home work1, Please replace error function by distance function