

Official tutorials: <https://www.tensorflow.org/tutorials>
keras totutial for MNIST: <https://www.tensorflow.org/tutorials/quickstart/beginne>

```
import numpy as np
import tensorflow as tf
```

☞ The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you [upgrade](#) now or ensure your notebook will continue to use TensorFlow 1.x via the %t

```
# Build an easy calculator
a = tf.placeholder(dtype=tf.float32, shape=[3,3])
b = tf.placeholder(dtype=tf.float32, shape=[3,3])
c = a+b
d = tf.matmul(a, b)
print(a)
print(b)
print(c)
print(d)
```

☞ Tensor("Placeholder:0", shape=(3, 3), dtype=float32)
Tensor("Placeholder_1:0", shape=(3, 3), dtype=float32)
Tensor("add:0", shape=(3, 3), dtype=float32)
Tensor("MatMul:0", shape=(3, 3), dtype=float32)

```
sess = tf.Session()
a_input = np.array([[1,1,1],[2,2,2],[3,3,3]])
b_input = np.array([[1,2,3],[1,2,3],[1,2,3]])
my_feed_dict = {a: a_input, b: b_input}
res = sess.run([c,d], feed_dict=my_feed_dict)
print(res[0])
print(res[1])
```

☞ [[2. 3. 4.]
[3. 4. 5.]
[4. 5. 6.]]
[[3. 6. 9.]
[6. 12. 18.]
[9. 18. 27.]]

```
e = tf.Variable(0.0)
e_add = tf.assign(e, e+1)
```

```
print(sess.run(e))
```

☞ -----
Red 1.3D visualization from Googlebooks (most recent call 1.3D)

```

FailedPreconditionError                                Traceback (most recent call last)
/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/client/session.p
  1364         try:
-> 1365             return fn(*args)
  1366     except errors.OpError as e:

```

⏏ 6 frames

```

FailedPreconditionError: 2 root error(s) found.
(0) Failed precondition: Attempting to use uninitialized value Variable
    [[{{node Variable}}]]
(1) Failed precondition: Attempting to use uninitialized value Variable
    [[{{node Variable}}]]
    [[Variable/_9]]
0 successful operations.
0 derived errors ignored.

```

During handling of the above exception, another exception occurred:

```

FailedPreconditionError                                Traceback (most recent call last)
/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/client/session.p
  1382                                     '\nsession_config.graph_options.rewrite_options.'
  1383                                     'disable_meta_optimizer = True')
-> 1384         raise type(e)(node_def, op, message)
  1385
  1386     def _extend_graph(self):

```

```

FailedPreconditionError: 2 root error(s) found.
(0) Failed precondition: Attempting to use uninitialized value Variable
    [[node Variable (defined at /usr/local/lib/python3.6/dist-packages/te
(1) Failed precondition: Attempting to use uninitialized value Variable
    [[node Variable (defined at /usr/local/lib/python3.6/dist-packages/te
    [[Variable/_9]]
0 successful operations.
0 derived errors ignored.

```

Original stack trace for 'Variable':

```

File "/usr/lib/python3.6/runpy.py", line 193, in _run_module_as_main
    "__main__", mod_spec)
File "/usr/lib/python3.6/runpy.py", line 85, in _run_code
    exec(code, run_globals)
File "/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py", line 16
    app.launch_new_instance()
File "/usr/local/lib/python3.6/dist-packages/traitlets/config/application.py
    app.start()
File "/usr/local/lib/python3.6/dist-packages/ipykernel/kernelapp.py", line 4
    ioloop.IOLoop.instance().start()
File "/usr/local/lib/python3.6/dist-packages/tornado/ioloop.py", line 832, i
    self._run_callback(self._callbacks.popleft())
File "/usr/local/lib/python3.6/dist-packages/tornado/ioloop.py", line 605, i
    ret = callback()
File "/usr/local/lib/python3.6/dist-packages/tornado/stack_context.py", line
    return fn(*args, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/zmq/eventloop/zmqstream.py", li
    self.io_loop.add_callback(lambda : self._handle_events(self.socket, 0))

```

```

File "/usr/local/lib/python3.6/dist-packages/zmq/eventloop/zmqstream.py", line 110, in
    self._handle_recv()
File "/usr/local/lib/python3.6/dist-packages/zmq/eventloop/zmqstream.py", line 110, in
    self._run_callback(callback, msg)
File "/usr/local/lib/python3.6/dist-packages/zmq/eventloop/zmqstream.py", line 110, in
    callback(*args, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/tornado/stack_context.py", line 27, in
    return fn(*args, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/ipykernel/kernelbase.py", line 47, in
    return self.dispatch_shell(stream, msg)
File "/usr/local/lib/python3.6/dist-packages/ipykernel/kernelbase.py", line 47, in
    handler(stream, idents, msg)
File "/usr/local/lib/python3.6/dist-packages/ipykernel/kernelbase.py", line 47, in
    user_expressions, allow_stdin)
File "/usr/local/lib/python3.6/dist-packages/ipykernel/ipkernel.py", line 190, in
    res = shell.run_cell(code, store_history=store_history, silent=silent)
File "/usr/local/lib/python3.6/dist-packages/ipykernel/zmqshell.py", line 53, in
    return super(ZMQInteractiveShell, self).run_cell(*args, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/IPython/core/interactiveshell.py", line 214, in
    interactivity=interactivity, compiler=compiler, result=result)
File "/usr/local/lib/python3.6/dist-packages/IPython/core/interactiveshell.py", line 214, in
    if self.run_code(code, result):
File "/usr/local/lib/python3.6/dist-packages/IPython/core/interactiveshell.py", line 214, in
    exec(code_obj, self.user_global_ns, self.user_ns)
File "<ipython-input-5-9281da998ca4>", line 1, in <module>
    e = tf.Variable(0.0)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/variable_ops.py", line 110, in
    return cls._variable_v1_call(*args, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/variable_ops.py", line 110, in
    shape=shape)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/variable_ops.py", line 110, in
    previous_getter = lambda **kwargs: default_variable_creator(None, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/variable_ops.py", line 110, in
    shape=shape)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/variable_ops.py", line 110, in
    return super(VariableMetaclass, cls).__call__(*args, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/variable_ops.py", line 110, in
    shape=shape)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/variable_ops.py", line 110, in
    shape, self._initial_value.dtype.base_dtype, name=name)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/stat_ops.py", line 110, in
    shared_name=shared_name)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/gen_ops.py", line 110, in
    shared_name=shared_name, name=name)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/framework/op_def_library.py", line 110, in
    op_def=op_def)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/util/deprecation.py", line 110, in
    return func(*args, **kwargs)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/framework/op_def_library.py", line 110, in
    attrs, op_def, compute_device)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/framework/op_def_library.py", line 110, in
    op_def=op_def)
File "/usr/local/lib/python3.6/dist-packages/tensorflow_core/python/framework/op_def_library.py", line 110, in
    self.traceback = tf.stack.extract_stack()

```

```
sess.run(tf.global_variables_initializer())  
print(sess.run(e))  
sess.run(e_add)  
print(sess.run(e))
```

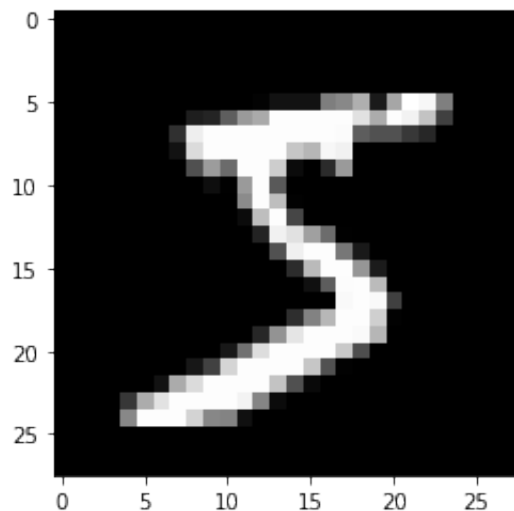
```
↳ 0.0  
   1.0
```

```
# build an easy neuron network  
# load in the data  
mnist = tf.keras.datasets.mnist  
(x_train, y_train), (x_test, y_test) = mnist.load_data()  
x_train, x_test = x_train / 255.0, x_test / 255.0  
print(x_train.shape)  
print(y_train.shape)
```

```
↳ (60000, 28, 28)  
   (60000,)
```

```
import matplotlib.pyplot as plt  
plt.imshow(x_train[0], cmap='gray')
```

```
↳ <matplotlib.image.AxesImage at 0x7f88611fcfd0>
```



```

# define structure: 784-->256-->10
input_img = tf.placeholder(dtype=tf.float32, shape=[None, 28*28], name='input')
labels = tf.placeholder(dtype=tf.int32, shape=[None], name='label')
h1 = tf.layers.dense(input_img, units=256, name='h1')
h1 = tf.nn.relu(h1)
h2 = tf.layers.dense(h1, units=10, name='h2')
output = tf.nn.softmax(h2)
print(h1.shape)
print(h2.shape)
print(output.shape)
print(labels.shape)

[ ] WARNING:tensorflow:From <ipython-input-11-84e593ecee8f>:3: dense (from tensorflow
Instructions for updating:
Use keras.layers.Dense instead.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core
Instructions for updating:
Please use `layer.__call__` method instead.
(?, 256)
(?, 10)
(?, 10)
(?,)

# define loss and optimizer
loss = tf.nn.sparse_softmax_cross_entropy_with_logits(labels=labels, logits=output,
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)
update = optimizer.minimize(loss)

sess = tf.Session()
sess.run(tf.global_variables_initializer())
cur_input = np.reshape(x_train[0:10], (10, 784))
cur_label = y_train[0:10]
my_feed_dict = {input_img: cur_input, labels:cur_label}
pred,_ = sess.run([output, update], feed_dict=my_feed_dict)
print(pred[0])
pred_new = sess.run(output, feed_dict=my_feed_dict)
print(pred_new[0])

[ ] [0.09353787 0.10248929 0.07982166 0.1008869 0.10314557 0.12986907
0.11714023 0.11106355 0.08724058 0.07480533]
[0.09398966 0.10327062 0.07952183 0.10195649 0.10206752 0.14129728
0.1144796 0.10677237 0.08383035 0.07281426]

```

```
model = tf.keras.models.Sequential([
    tf.keras.layers.Flatten(input_shape=(28, 28)),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dense(10, activation='softmax')
])

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

```
☞ WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core
Instructions for updating:
If using Keras pass *_constraint arguments to layers.
```

```
model.fit(x_train, y_train, epochs=20)

model.evaluate(x_test, y_test, verbose=2)
```

☞ Train on 60000 samples

```
Epoch 1/20
60000/60000 [=====] - 4s 58us/sample - loss: 0.6461 -
Epoch 2/20
60000/60000 [=====] - 3s 58us/sample - loss: 0.3422 -
Epoch 3/20
60000/60000 [=====] - 3s 58us/sample - loss: 0.2946 -
Epoch 4/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.2639 -
Epoch 5/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.2408 -
Epoch 6/20
60000/60000 [=====] - 3s 58us/sample - loss: 0.2222 -
Epoch 7/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.2066 -
Epoch 8/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.1928 -
Epoch 9/20
60000/60000 [=====] - 4s 60us/sample - loss: 0.1814 -
Epoch 10/20
60000/60000 [=====] - 3s 58us/sample - loss: 0.1710 -
Epoch 11/20
60000/60000 [=====] - 3s 56us/sample - loss: 0.1621 -
Epoch 12/20
60000/60000 [=====] - 4s 60us/sample - loss: 0.1536 -
Epoch 13/20
60000/60000 [=====] - 4s 60us/sample - loss: 0.1460 -
Epoch 14/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.1394 -
Epoch 15/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.1330 -
Epoch 16/20
60000/60000 [=====] - 3s 57us/sample - loss: 0.1273 -
Epoch 17/20
60000/60000 [=====] - 3s 58us/sample - loss: 0.1220 -
Epoch 18/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.1172 -
Epoch 19/20
60000/60000 [=====] - 4s 59us/sample - loss: 0.1125 -
Epoch 20/20
60000/60000 [=====] - 4s 60us/sample - loss: 0.1086 -
10000/10000 - 0s - loss: 0.1164 - acc: 0.9660
[0.11640410664901138, 0.966]
```

