

C2_W1_Lab_1_basic-tensors

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1 Basic Tensors

In this ungraded lab, you will try some of the basic operations you can perform on tensors.

1.1 Imports

```
[1]: try:
      # %tensorflow_version only exists in Colab.
      %tensorflow_version 2.x
    except Exception:
      pass

    import tensorflow as tf
    import numpy as np
```

1.2 Exercise on basic Tensor operations

Lets create a single dimension numpy array on which you can perform some operation. You'll make an array of size 25, holding values from 0 to 24.

```
[2]: # Create a 1D uint8 NumPy array comprising of first 25 natural numbers
x = np.arange(0, 25)
x
```

```
[2]: array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
          17, 18, 19, 20, 21, 22, 23, 24])
```

Now that you have your 1-D array, next you'll change that array into a **tensor**. After running the code block below, take a moment to inspect the information of your tensor.

```
[3]: # Convert NumPy array to Tensor using `tf.constant`
x = tf.constant(x)
x
```

```
[3]: <tf.Tensor: shape=(25,), dtype=int64, numpy=
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
```

```
17, 18, 19, 20, 21, 22, 23, 24]])>
```

As the first operation to be performed, you'll square (element-wise) all the values in the tensor `x`

```
[4]: # Square the input tensor x
x = tf.square(x)
x
```

```
[4]: <tf.Tensor: shape=(25,), dtype=int64, numpy=
array([ 0,  1,  4,  9, 16, 25, 36, 49, 64, 81, 100, 121, 144,
       169, 196, 225, 256, 289, 324, 361, 400, 441, 484, 529, 576])>
```

One feature of tensors is that they can be reshaped. When reshaping, make sure you consider dimensions that will include all of the values of the tensor.

```
[5]: # Reshape tensor x into a 5 x 5 matrix.
x = tf.reshape(x, (5, 5))
x
```

```
[5]: <tf.Tensor: shape=(5, 5), dtype=int64, numpy=
array([[ 0,  1,  4,  9, 16],
       [25, 36, 49, 64, 81],
       [100, 121, 144, 169, 196],
       [225, 256, 289, 324, 361],
       [400, 441, 484, 529, 576]])>
```

Notice that you'll get an error message if you choose a shape that cannot be exactly filled with the values of the given tensor.

* Run the cell below and look at the error message * Try to change the tuple that is passed to `shape` to avoid an error.

```
[6]: # Try this and look at the error
# Try to change the input to `shape` to avoid an error
tmp = tf.constant([1,2,3,4])
tf.reshape(tmp, shape=(2,3))
```

```

↳ -----
InvalidArgumentError                                Traceback (most recent call↳
↳last)

<ipython-input-6-4a03bca24981> in <module>
      2 # Try to change the input to `shape` to avoid an error
      3 tmp = tf.constant([1,2,3,4])
----> 4 tf.reshape(tmp, shape=(2,3))
```

```

/opt/conda/lib/python3.7/site-packages/tensorflow/python/util/dispatch.
↳py in wrapper(*args, **kwargs)
    199     """Call target, and fall back on dispatchers if there is a
↳TypeError."""
    200     try:
--> 201         return target(*args, **kwargs)
    202     except (TypeError, ValueError):
    203         # Note: convert_to_eager_tensor currently raises a ValueError,
↳not a

```

```

/opt/conda/lib/python3.7/site-packages/tensorflow/python/ops/array_ops.
↳py in reshape(tensor, shape, name)
    193     A `Tensor`. Has the same type as `tensor`.
    194     """
--> 195     result = gen_array_ops.reshape(tensor, shape, name)
    196     tensor_util.maybe_set_static_shape(result, shape)
    197     return result

```

```

/opt/conda/lib/python3.7/site-packages/tensorflow/python/ops/
↳gen_array_ops.py in reshape(tensor, shape, name)
    8227     try:
    8228         return reshape_eager_fallback(
-> 8229             tensor, shape, name=name, ctx=_ctx)
    8230     except _core._SymbolicException:
    8231         pass # Add nodes to the TensorFlow graph.

```

```

/opt/conda/lib/python3.7/site-packages/tensorflow/python/ops/
↳gen_array_ops.py in reshape_eager_fallback(tensor, shape, name, ctx)
    8252     _attrs = ("T", _attr_T, "Tshape", _attr_Tshape)
    8253     _result = _execute.execute(b"Reshape", 1, inputs=_inputs_flat,
↳attrs=_attrs,
-> 8254         ctx=ctx, name=name)
    8255     if _execute.must_record_gradient():
    8256         _execute.record_gradient(

```

```

/opt/conda/lib/python3.7/site-packages/tensorflow/python/eager/execute.
↳py in quick_execute(op_name, num_outputs, inputs, attrs, ctx, name)
    58     ctx.ensure_initialized()
    59     tensors = pywrap_tfe.TFE_Py_Execute(ctx._handle, device_name,
↳op_name,
---> 60         inputs, attrs, num_outputs)
    61     except core._NotOkStatusException as e:

```

```
62     if name is not None:
```

InvalidArgumentError: Input to reshape is a tensor with 4 values, but
↳the requested shape has 6 [Op:Reshape]

Like reshaping, you can also change the data type of the values within the tensor. Run the cell below to change the data type from int to float

```
[7]: # Cast tensor x into float32. Notice the change in the dtype.
x = tf.cast(x, tf.float32)
x
```

```
[7]: <tf.Tensor: shape=(5, 5), dtype=float32, numpy=
array([[ 0.,  1.,  4.,  9., 16.],
       [25., 36., 49., 64., 81.],
       [100., 121., 144., 169., 196.],
       [225., 256., 289., 324., 361.],
       [400., 441., 484., 529., 576.]], dtype=float32)>
```

Next, you'll create a single value float tensor by the help of which you'll see **broadcasting** in action

```
[8]: # Let's define a constant and see how broadcasting works in the following cell.
y = tf.constant(2, dtype=tf.float32)
y
```

```
[8]: <tf.Tensor: shape=(), dtype=float32, numpy=2.0>
```

Multiply the tensors x and y together, and notice how multiplication was done and its result.

```
[9]: # Multiply tensor `x` and `y`. `y` is multiplied to each element of x.
result = tf.multiply(x, y)
result
```

```
[9]: <tf.Tensor: shape=(5, 5), dtype=float32, numpy=
array([[ 0.,  2.,  8., 18., 32.],
       [50., 72., 98., 128., 162.],
       [200., 242., 288., 338., 392.],
       [450., 512., 578., 648., 722.],
       [800., 882., 968., 1058., 1152.]], dtype=float32)>
```

Re-Initialize y to a tensor having more values.

```
[10]: # Now let's define an array that matches the number of row elements in the `x`
↳array.
y = tf.constant([1, 2, 3, 4, 5], dtype=tf.float32)
y
```

```
[10]: <tf.Tensor: shape=(5,), dtype=float32, numpy=array([1., 2., 3., 4., 5.],
dtype=float32)>
```

```
[11]: # Let's see first the contents of `x` again.
x
```

```
[11]: <tf.Tensor: shape=(5, 5), dtype=float32, numpy=
array([[ 0.,  1.,  4.,  9., 16.],
       [25., 36., 49., 64., 81.],
       [100., 121., 144., 169., 196.],
       [225., 256., 289., 324., 361.],
       [400., 441., 484., 529., 576.]], dtype=float32)>
```

Add the tensors `x` and `y` together, and notice how addition was done and its result.

```
[12]: # Add tensor `x` and `y`. `y` is added element wise to each row of `x`.
result = x + y
result
```

```
[12]: <tf.Tensor: shape=(5, 5), dtype=float32, numpy=
array([[ 1.,  3.,  7., 13., 21.],
       [26., 38., 52., 68., 86.],
       [101., 123., 147., 173., 201.],
       [226., 258., 292., 328., 366.],
       [401., 443., 487., 533., 581.]], dtype=float32)>
```

1.2.1 The shape parameter for `tf.constant`

When using `tf.constant()`, you can pass in a 1D array (a vector) and set the `shape` parameter to turn this vector into a multi-dimensional array.

```
[13]: tf.constant([1,2,3,4], shape=(2,2))
```

```
[13]: <tf.Tensor: shape=(2, 2), dtype=int32, numpy=
array([[1, 2],
       [3, 4]], dtype=int32)>
```

1.2.2 The shape parameter for `tf.Variable`

Note, however, that for `tf.Variable()`, the shape of the tensor is derived from the shape given by the input array. Setting `shape` to something other than `None` will not reshape a 1D array into a multi-dimensional array, and will give a `ValueError`.

```
[14]: try:
      # This will produce a ValueError
      tf.Variable([1,2,3,4], shape=(2,2))
```

```
except ValueError as v:  
    # See what the ValueError says  
    print(v)
```

The initial value's shape ((4,)) is not compatible with the explicitly supplied `shape` argument ((2, 2)).

[]: