Basic Tensor operations and GradientTape.

In this graded assignment, you will perform different tensor operations as well as use GradientTape. These are important building blocks for the next parts of this course so it's important to master the basics. Let's begin!

In [1]:
```
import tensorflow as tf
import numpy as np
```

Exercise 1 - tf.constant

Creates a constant tensor from a tensor-like object.

In [2]:
```
# Convert NumPy array to Tensor using `tf.constant`
def tf_constant(array):
    """
    Args:
        array (numpy.ndarray): tensor-like array.

    Returns:
        tensorflow.python.framework.ops.EagerTensor: tensor.
    """
    ### START CODE HERE ###
    tf_constant_array = tf.constant(array)
    ### END CODE HERE ###
    return tf_constant_array
```

In [3]:
```
tmp_array = np.arange(1,10)
x = tf_constant(tmp_array)
x

# Expected output:
# <tf.Tensor: shape=(9,), dtype=int64, numpy=array([1, 2, 3, 4, 5, 6, 7, 8, 9])>
```

Out[3]:
```
<tf.Tensor: shape=(9,), dtype=int64, numpy=array([1, 2, 3, 4, 5, 6, 7, 8, 9])>
```

Note that for future docstrings, the type `EagerTensor` will be used as a shortened version of `tensorflow.python.framework.ops.EagerTensor`.

Exercise 2 - tf.square

Computes the square of a tensor element-wise.

In [4]:
```
# Square the input tensor
def tf_square(array):
    """
    Args:
        array (numpy.ndarray): tensor-like array.

    Returns:
        EagerTensor: tensor.
    """
    # make sure it's a tensor
    array = tf.constant(array)

    ### START CODE HERE ###
    tf_squared_array = tf.square(array)
    ### END CODE HERE ###
    return tf_squared_array
```

In [5]:
```
tmp_array = tf.constant(np.arange(1, 10))
x = tf_square(tmp_array)
x

# Expected output:
# <tf.Tensor: shape=(9,), dtype=int64, numpy=array([ 1,  4,  9, 16, 25, 36, 49, 64, 81])>
```

Out[5]:
```
<tf.Tensor: shape=(9,), dtype=int64, numpy=array([ 1,  4,  9, 16, 25, 36, 49, 64, 81])>
```

Exercise 3 - tf.reshape

Reshapes a tensor.

In [6]:
```
# Reshape tensor into the given shape parameter
def tf_reshape(array, shape):
    """
    Args:
        array (EagerTensor): tensor to reshape.
        shape (tuple): desired shape.

    Returns:
        EagerTensor: reshaped tensor.
    """
    # make sure it's a tensor
    array = tf.constant(array)
    ### START CODE HERE ###
    tf_reshaped_array = tf.reshape(array, shape)
    ### END CODE HERE ###
    return tf_reshaped_array
```

In [7]:
```
# Check your function
tmp_array = np.array([1,2,3,4,5,6,7,8,9])
# Check that your function reshapes a vector into a matrix
x = tf_reshape(tmp_array, (3, 3))
x

# Expected output:
# <tf.Tensor: shape=(3, 3), dtype=int64, numpy=
# [[1, 2, 3],
# [4, 5, 6],
# [7, 8, 9]]
```

Out[7]:
```
<tf.Tensor: shape=(3, 3), dtype=int64, numpy=
array([[1, 2, 3],
       [4, 5, 6],
       [7, 8, 9]])>
```

Exercise 4 - tf.cast

Casts a tensor to a new type.

In [8]:
```
# Cast tensor into the given dtype parameter
def tf_cast(array, dtype):
    """
    Args:
        array (EagerTensor): tensor to be casted.
        dtype (tensorflow.python.framework.dtypes.DType): desired new type. (Should be a TF dtype!)

    Returns:
        EagerTensor: casted tensor.
    """
    # make sure it's a tensor
    array = tf.constant(array)

    ### START CODE HERE ###
    tf_cast_array = tf.cast(array, dtype)
    ### END CODE HERE ###
    return tf_cast_array
```

In [9]:
```
# Check your function
tmp_array = [1,2,3,4]
x = tf_cast(tmp_array, tf.float32)
x

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

Out[9]:
```
<tf.Tensor: shape=(4,), dtype=float32, numpy=array([1., 2., 3., 4.], dtype=float32)>
```

Exercise 5 - tf.multiply

Returns an element-wise x * y.

In [10]:
```
# Multiply tensor1 and tensor2
def tf_multiply(tensor1, tensor2):
    """
    Args:
        tensor1 (EagerTensor): a tensor.
        tensor2 (EagerTensor): another tensor.

    Returns:
        EagerTensor: resulting tensor.
    """
    # make sure these are tensors
    tensor1 = tf.constant(tensor1)
    tensor2 = tf.constant(tensor2)

    ### START CODE HERE ###
    product = tf.multiply(tensor1, tensor2)
    ### END CODE HERE ###
    return product
```

In [11]:
```
# Check your function
tmp_1 = tf.constant(np.array([[1,2],[3,4]]))
tmp_2 = tf.constant(np.array(2))
result = tf_multiply(tmp_1, tmp_2)
result

# Expected output:
# <tf.Tensor: shape=(2, 2), dtype=int64, numpy=
# array([[2, 4],
#        [6, 8]])>
```

Out[11]:
```
<tf.Tensor: shape=(2, 2), dtype=int64, numpy=
array([[2, 4],
       [6, 8]])>
```

Exercise 6 - tf.add

Returns x + y element-wise.

In [12]:
```
# Add tensor1 and tensor2
def tf_add(tensor1, tensor2):
    """
    Args:
        tensor1 (EagerTensor): a tensor.
        tensor2 (EagerTensor): another tensor.

    Returns:
        EagerTensor: resulting tensor.
    """
    # make sure these are tensors
    tensor1 = tf.constant(tensor1)
    tensor2 = tf.constant(tensor2)

    ### START CODE HERE ###
    total = tf.add(tensor1, tensor2)
    ### END CODE HERE ###
    return total
```

In [13]:
```
# Check your function
tmp_1 = tf.constant(np.array([1, 2, 3]))
tmp_2 = tf.constant(np.array([4, 5, 6]))
tf_add(tmp_1, tmp_2)

# Expected output:
# <tf.Tensor: shape=(3,), dtype=int64, numpy=array([5, 7, 9])>
```

Out[13]:
```
<tf.Tensor: shape=(3,), dtype=int64, numpy=array([5, 7, 9])>
```

Exercise 7 - Gradient Tape

Implement the function `tf_gradient_tape` by replacing the instances of `None` in the code below. The instructions are given in the code comments.

You can review the docs or revisit the lectures to complete this task.

In [14]:
```python
def tf_gradient_tape(x):
    """
    Args:
        x (EagerTensor): a tensor.

    Returns:
        EagerTensor: Derivative of z with respect to the input tensor x.
    """
    with tf.GradientTape() as t:

    ### START CODE HERE ###
        # Record the actions performed on tensor x with `watch`
        t.watch(x)

        # Define a polynomial of form 3x^3 - 2x^2 + x
        y = 3*x**3 - 2*x**2 + x

        # Obtain the sum of the elements in variable y
        z = tf.reduce_sum(y)

    # Get the derivative of z with respect to the original input tensor x
    dz_dx = t.gradient(z, x)
    ### END CODE HERE

    return dz_dx
```

In [15]:
```python
# Check your function
tmp_x = tf.constant(2.0)
dz_dx = tf_gradient_tape(tmp_x)
result = dz_dx.numpy()
result

# Expected output:
# 29.0
```

Out[15]: 29.0

Congratulations on finishing this week's assignment!

Keep it up!