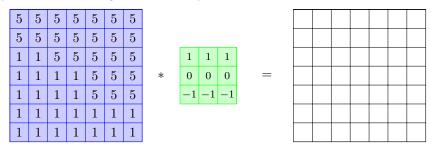
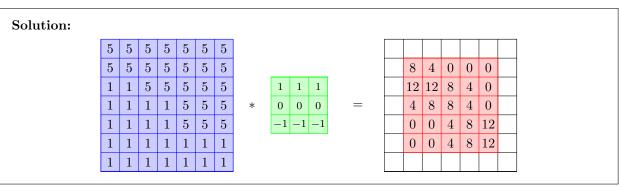
$\begin{array}{c|c} Tutorial\ Questions \mid Week\ 5 \\ \hline \text{COSC2779 - Deep\ Learning} \end{array}$

This tutorial is aimed at reviewing convolutions in deep learning. Please try the questions before you join the session.

1. What is the output of the following convolution operation?





2. What is the output of Pooling the following input with 3x3 max-pooling with stride 2?

1	6	2	8	1	2	7
1	6	2	8	1	2	5
0	5	8	1	5	7	1
1	7	1	3	5	8	0
5	2	4	4	5	8	4
8	2	3	7	3	8	2
1	2	3	6	5	9	6

```
Solution:
                                   2
                      6
                         2
                            8
                                1
                                   2
                                      5
                   0
                      5
                         8
                            1
                                5
                                   7
                                      1
                      7
                            3
                                5
                   1
                         1
                                   8
                                      0
                                                                             8
                   5
                                   8
                      2
                         4
                            4
                                5
                                      4
                                                                             7
                   8
                      2
                         3
                             7
                                3
                                   8
                                      2
                      2
                         3
                            6
                               5
                                   9
```

3. Calculate the output shape at the end of each layer and the number of parameters for the following network.

```
model = tf.keras.Sequential()
model.add(Conv2D(6, kernel_size=(5, 5), strides=(1, 1), activation='tanh', input_shape=(32,32,1),
    padding="valid"))
model.add(AveragePooling2D(pool_size=(2, 2), strides=(2, 2), padding='valid'))
model.add(Conv2D(16, kernel_size=(5, 5), strides=(1, 1), activation='tanh', padding='valid'))
```

```
model.add(AveragePooling2D(pool_size=(2, 2), strides=(2, 2), padding='valid'))
model.add(Flatten())
model.add(Dense(120, activation='tanh'))
model.add(Dense(84, activation='tanh'))
model.add(Dense(10, activation='softmax'))
```

Solution: Layer (type) Output Shape Param # conv2d_2 (Conv2D) 156 (None, 28, 28, 6) average_pooling2d_2 (Average (None, 14, 14, 6) conv2d_3 (Conv2D) (None, 10, 10, 16) 2416 average_pooling2d_3 (Average (None, 5, 5, 16) 0 flatten_1 (Flatten) (None, 400) 0 dense_3 (Dense) (None, 120) 48120 dense_4 (Dense) 10164 (None, 84) dense_5 (Dense) (None, 10) 850 Total params: 61,706 Trainable params: 61,706 Non-trainable params: 0

4. Calculate the receptive field of the second convolution layer of the above network.

Solution: 14x14

5. Calculate the receptive field of the second convolution layer of the above network if the Dilation of first convolution layer was set to 2?

Solution: 18x18