Tutorial Questions | Week 5

COSC2779 - Deep Learning

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?

5	5	5	5	5	5	5
5	5	5	5	5	5	5
1	1	5	5	5	5	5
1	1	1	1	5	5	5
1	1	1	1	5	5	5
1	1	1	1	1	1	1
1	1	1	1	1	1	1

$*$

1	1	1
0	0	0
−1	−1	−1

$=$

Solution:

5	5	5	5	5	5	5
5	5	5	5	5	5	5
1	1	5	5	5	5	5
1	1	1	1	5	5	5
1	1	1	1	5	5	5
1	1	1	1	1	1	1
1	1	1	1	1	1	1

$*$

1	1	1
0	0	0
−1	−1	−1

$=$

	8	4	0	0	0	
	12	12	8	4	0	
	4	8	8	4	0	
	0	0	4	8	12	
	0	0	4	8	12	

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:

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

8	8	7
8	8	8
8	7	8

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)            (None, 28, 28, 6)         156
_________________________________________________________________
average_pooling2d_2 (Average (None, 14, 14, 6)         0
_________________________________________________________________
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)              (None, 84)                10164
_________________________________________________________________
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