1.(a) (100,256,256,3)

(b) (40, 2400, 80)

(c) (32, 300, 512, 512,3)

2

(a) $0 \le k_1 < 2, 0 \le k_2 \le 2$

(b)the size of Z[i,j] is (5,4)

(c) the largest positive value of Z[i,j] is 6 , the pixel can be (3,1)

(d) the largest negative value of Z[i,j] is -6, the pixel can be (3,0)

(e)the pixel can be (0,1)

3.

(a) the shapes of Z and U are both (46,62,20).

(b)the input channel is 10, the output channel is 20.

(c) $3 * 3 * 46 * 62 = 25668$, there are 90 multiplications to be performed.

(d) 3 * 3* 10* 20 +20 = 1820, there are 1820 trainable parameters in this layer.

4.

(a) $\frac{\partial J}{\partial Z[i,j_1,j_2,m]} = \frac{\partial J}{\partial U[i,j_1,j_2,m]} * \frac{\partial U[i,j_1,j_2,m]}{\partial Z[i,j_1,j_2,m]}$

$\frac{\partial U[i,j_1,j_2,m]}{\partial Z[i,j_1,j_2,m]} = -\frac{1}{\left(1+e^{-Z[i,j_1,j_2,m]}\right)^2} * -e^{-Z[i,j_1,j_2,m]} = \frac{e^{-Z[i,j_1,j_2,m]}}{\left(1+e^{-Z[i,j_1,j_2,m]}\right)^2}$

so $\frac{\partial J}{\partial Z[i,j_1,j_2,m]} = \frac{\partial J}{\partial U[i,j_1,j_2,m]} * \frac{e^{-Z[i,j_1,j_2,m]}}{\left(1+e^{-Z[i,j_1,j_2,m]}\right)^2}$

(b) $\frac{\partial J}{\partial W[k_1,k_2,n,m]} = \frac{\partial J}{\partial Z[i,j_1,j_2,m]} * \frac{\partial Z[i,j_1,j_2,m]}{\partial W[k_1,k_2,n,m]} = \frac{\partial J}{\partial U[i,j_1,j_2,m]} * \frac{e^{-Z[i,j_1,j_2,m]}}{\left(1+e^{-Z[i,j_1,j_2,m]}\right)^2} * \sum_{j_1}\sum_{j_2} X[i, j_1 + k_1, j_2 + k_2, n]$

(c) $\frac{\partial J}{\partial X[i,j_1,j_2,n]} = \frac{\partial J}{\partial Z[i,j_1,j_2,m]} * \frac{\partial Z[i,j_1,j_2,m]}{\partial X[i,j_1,j_2,n]} = \frac{\partial J}{\partial U[i,j_1,j_2,m]} * \frac{e^{-Z[i,j_1,j_2,m]}}{\left(1+e^{-Z[i,j_1,j_2,m]}\right)^2} * \sum_m W[0,0,n,m]$

5.

(a) y = [1, 3, 0, 1]

(b) y = [2, 3, 10, 1]

(c)

sub_sampling $y[i,k,n] = X[i, sk, n]$, $k = 0, 1, 2, \ldots, \left\lfloor \frac{(N-1)}{s} \right\rfloor$

max_pooling $y[i,k,n] = \max_{j=0,1,\ldots,p-1} X[i, sk + j, n]$, $k = 0, 1, 2, \ldots, \left\lfloor \frac{(N-1)}{s} \right\rfloor$

output shape = $\left(B, \left\lfloor \frac{(N-1)}{s} \right\rfloor + 1, C\right)$