1 Exercise 1

First we need to flip the kernel,which results in : $\begin{bmatrix} 1 & -2 & 1 \\ 1 & 2 & 2 \\ 1 & 1 & 1 \end{bmatrix}$, which is then convolved with I (I assume the convolution is a valid convolution without any sort of padding on I):

$$\text{I*k} = \begin{bmatrix} 1-2+1+1+4+4-1-2-2 & 1-2+1+2+4+2-2-2-1 \\ 11-4+2-1-4-4-1-1-1 & 2-4+1-2-4-2-1-1-1 \end{bmatrix}$$

, which results in following result $\begin{bmatrix} 4 & 3 \\ -13 & -12 \end{bmatrix}$

2 Exercise 2

Applying Max Pooling with a (3,3) filter with stride 3 results in a final image of size one third of the initial image, so the result of this operation on I is :

$$\begin{bmatrix} 6 & 3 \\ 2 & 1 \end{bmatrix}$$

3 Exercise 3

3.1 Convolution

Convolving I with k yields I*k (assumption,valid convolution with no padding)

$$= \begin{bmatrix} 7 & 10 & 10 & 6 \\ 2 & 4 & 3 & 0 \\ -8 & -13 & -12 & -6 \\ -4 & -4 & -4 & -3 \end{bmatrix}$$

3.2 Rectified Linear Unit

The ReLU has the activation function max(0,x), which, when applied to the result above yields : $\begin{bmatrix} 7 & 10 & 10 & 6 \\ 2 & 4 & 3 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

3.3 Max Pooling

Max Pooling with stride 2 (with stride it makes no sense, when the assumption is a valid convolution), yields $\begin{bmatrix} 10 & 10 \\ 0 & 0 \end{bmatrix}$

3.4 Flatten

Flatten the result yields : $\begin{bmatrix} 10 & 10 & 0 & 0 \end{bmatrix}^T$

3.5 Output

Multiplying the Weight Matrix with the flattened vector yields : $\begin{bmatrix} 30 \\ 110 \end{bmatrix}$, so we would select the 2nd class.