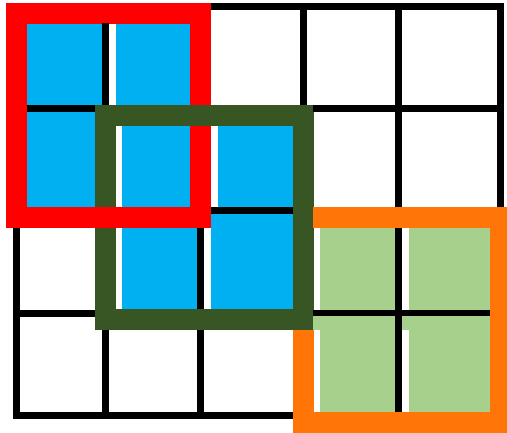


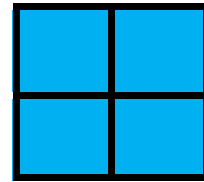
ReLU:  $f(x) = \max(x, 0)$

# Introduction to CNN

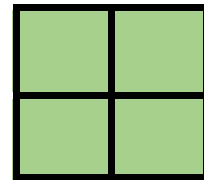
Input:



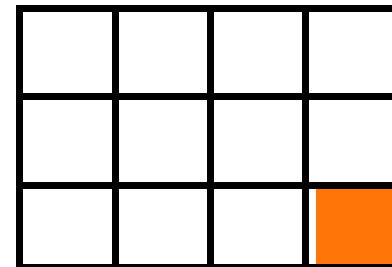
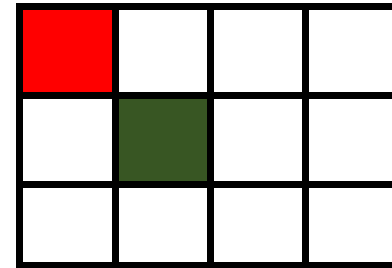
Filters:



2x2 Filter

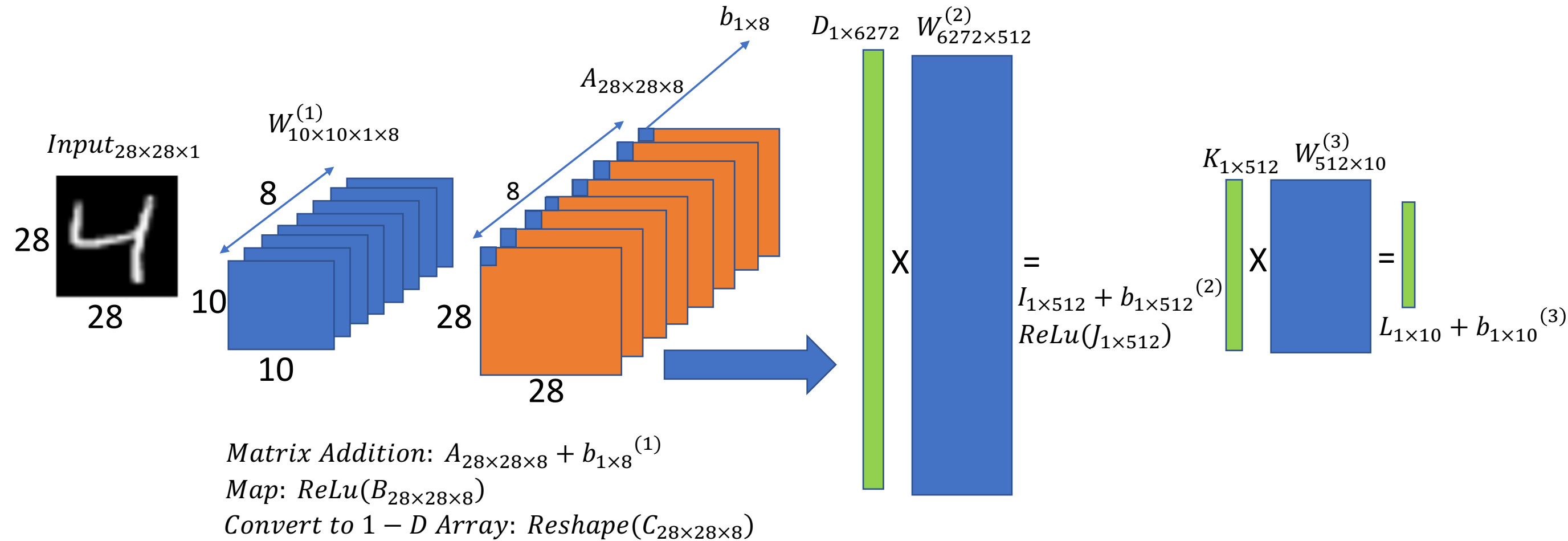


Output:



$$Output_k[x][y] = \sum_{c=0}^C \sum_{j=0}^F \sum_{i=0}^F Image[x.S + i][y.S + j][d] \times Filter_k[i][j][c]$$
$$0 \leq x \leq W_o,$$
$$0 \leq y \leq H_o$$

# CNN Model:



# Required computations

- $A_{28 \times 28 \times 8} = Input_{28 \times 28 \times 1} * W_{10 \times 10 \times 1 \times 8}^{(1)}$  (Note: “\*” is convolution as in equation 1)
- $B_{28 \times 28 \times 8} = A_{28 \times 28 \times 8} + b_{1 \times 8}^{(1)}$  (Note: the scalar bias for each filter is added to all elements of the matrix)
- $C_{28 \times 28 \times 8} = ReLu(B_{28 \times 28 \times 8})$
- $D_{1 \times 6272} = Reshape(C_{28 \times 28 \times 8})$
- $I_{1 \times 512} = D_{1 \times 6272} \times W_{6272 \times 512}^{(2)}$
- $J_{1 \times 512} = I_{1 \times 512} + b_{1 \times 512}^{(2)}$
- $K_{1 \times 512} = ReLu(J_{1 \times 512})$
- $L_{1 \times 10} = K_{1 \times 512} \times W_{512 \times 10}^{(3)}$
- $Output_{1 \times 10} = L_{1 \times 10} + b_{1 \times 10}^{(3)}$

# Layer-by-layer parameters

Tensor_name	Layer name	Filter size(FxF)	# of channels (C )	# of filters (K)	Matrix dimensions	File name
Variable	Conv1	10x10	1	8	$W_{10 \times 10 \times 1 \times 8}^{(1)}$	Conv_w
Variable_1	Conv1				$b_{1 \times 8}^{(1)}$	Conv_b
Variable_2	Fc1	1x1	6272	512	$W_{6272 \times 512}^{(2)}$	Fc1_w
Variable_3	Fc1				$b_{1 \times 512}^{(2)}$	Fc1_b
Variable_4	Fc2	1x1	512	10	$W_{512 \times 10}^{(3)}$	Fc2_w
Variable_5	Fc2				$b_{1 \times 10}^{(3)}$	Fc2_b