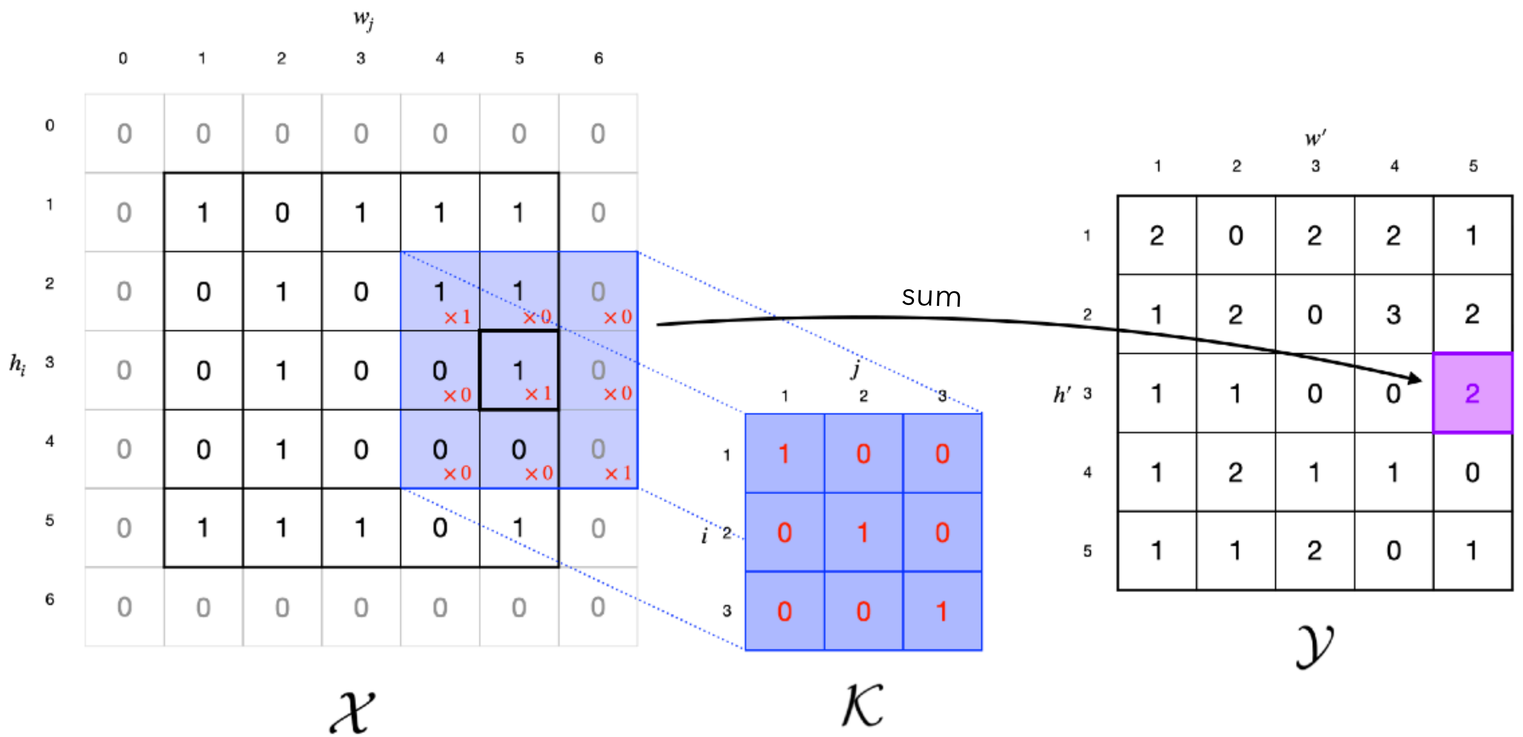
Method 2

The Convolution

$$\mathcal{Y}(f', h', w', t) = \sum_{i=1}^{D_F} \sum_{j=1}^{D_H} \sum_{l=1}^{D_W} \sum_{s=1}^{S} \mathcal{K}(i, j, l, s, t)\ \mathcal{X}(f_i, h_j, w_l, s)$$



Very simple example for images with only 1 input channel (black / white)

Method 2

Compressing the Convolution

$$\mathcal{K}(i,j,l,s,t) = \sum_{r_4=1}^{R_4} \sum_{r_5=1}^{R_5} \mathcal{C}(i,j,l,r_4,r_5)\, \boldsymbol{U}^{(4)}(s,r_4)\, \boldsymbol{U}^{(5)}(t,r_5)$$

Using this in the convolution:

$$\mathcal{Y}(f',h',w',t) = \sum_{i=1}^{D_F} \sum_{j=1}^{D_H} \sum_{l=1}^{D_W} \sum_{s=1}^{S} \sum_{r_4=1}^{R_4} \sum_{r_5=1}^{R_5} \mathcal{C}(i,j,l,r_4,r_5)\, \boldsymbol{U}^{(4)}(s,r_4)\, \boldsymbol{U}^{(5)}(t,r_5)\, \mathcal{X}(f_i,h_j,w_l,s)$$

Rearranging:

$$\mathcal{Y}(f',h',w',t) = \sum_{r_5=1}^{R_5} \boldsymbol{U}^{(5)}(t,r_5) \underbrace{\sum_{i=1}^{D_F} \sum_{j=1}^{D_H} \sum_{l=1}^{D_W} \sum_{r_4=1}^{R_4} \mathcal{C}(i,j,l,r_4,r_5) \underbrace{\sum_{s=1}^{S} \boldsymbol{U}^{(4)}(s,r_4)\, \mathcal{X}(f_i,h_j,w_l,s)}_{\mathcal{Q}(f_i,h_j,w_l,r_4)}}_{\mathcal{Q}'(f',h',w',r_5)}$$