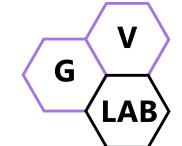
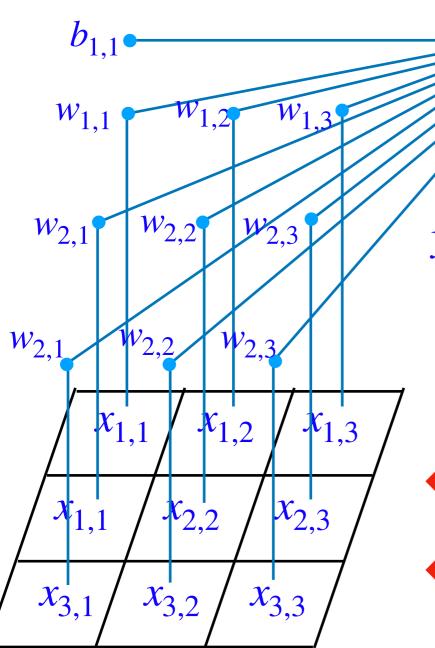
## **Fully-connected layer**

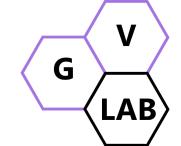


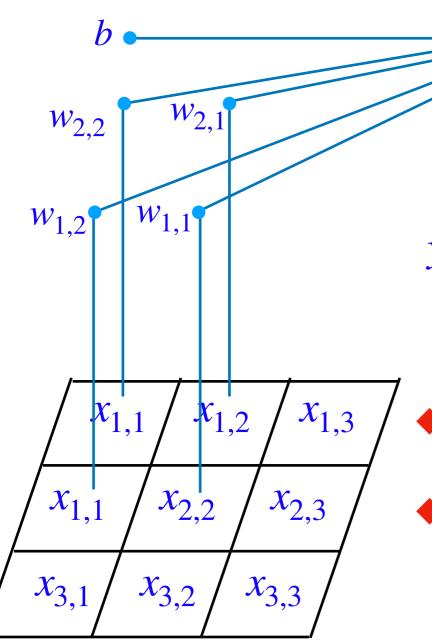


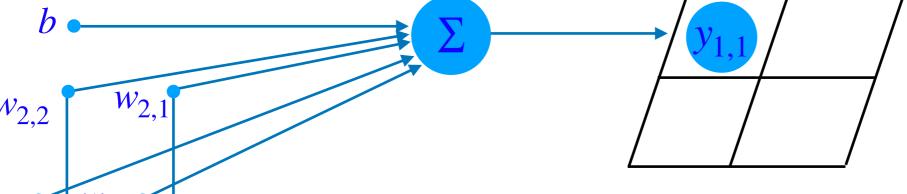
$$y_{1,1} = w_{1,1}x_{1,1} + w_{1,2}x_{1,2} + w_{1,3}x_{1,3} + w_{2,1}x_{2,1} + w_{2,2}x_{2,2} + w_{2,3}x_{2,3} + w_{3,1}x_{3,1} + w_{3,2}x_{3,2} + w_{3,3}x_{3,3} + b_{1,1}$$

- $lack each y_{u,v}$  uses different set of  $w_{m,n}$  and  $b_{u,v}$ 
  - $\Rightarrow$  # learnable parameters =  $9 \times 4 + 4 = 40$

## **Convolution layer**







$$y_{1,1} = w_{2,2}x_{1,1} + w_{2,1}x_{1,2} + w_{2,1}x_{2,1} + w_{1,1}x_{2,2} + b$$

- - **⇒** sparse connectivity
- lack all  $y_{u,v}$  share the same set of parameters:  $w_{m,n}$  and b
  - ⇒ parameter sharing
  - $\Rightarrow$  # learnable parameters = 4 + 1 = 5