

## GCN on Undirected Graph:

$$G = (V, E, X)$$

$\uparrow$  node     $\uparrow$  edge     $\uparrow$  feature of node  
 $|V| \times d_0$

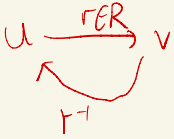
$$\begin{cases} H^{k+1} = f(\hat{A} H^k W^k) \\ H^0 = X \\ W^k \in \mathbb{R}^{d_k \times d_{k+1}} \end{cases}$$

## GCN on Multi-Relational Graph:

$$G = (V, R, E, X)$$

$\uparrow$   
 relation

$$(u, v, r)$$



$$H^{k+1} = f(\hat{A} H^k W^k) \rightarrow h_v = f\left(\sum_{(u,r) \in N(v)} W_{r,v}^k h_u\right)$$

## Comp GCN :

$$G = (V, R, E, X, Z)$$

$\uparrow$   
 initial relation feature  
 $|R| \times d_0$

$$\begin{cases} H_v^{k+1} = f\left(\sum_{(u,r) \in N(v)} W_{r,v}^k \phi(h_u^k, h_r^k)\right) \\ h_r^{k+1} = W_{rel}^k \cdot h_r^k \\ h_v^0, h_r^0 : \text{initial } x_v, z_r \\ W_{rel}^k : d_i \times d_o \end{cases}$$

out in self  
 composition operator