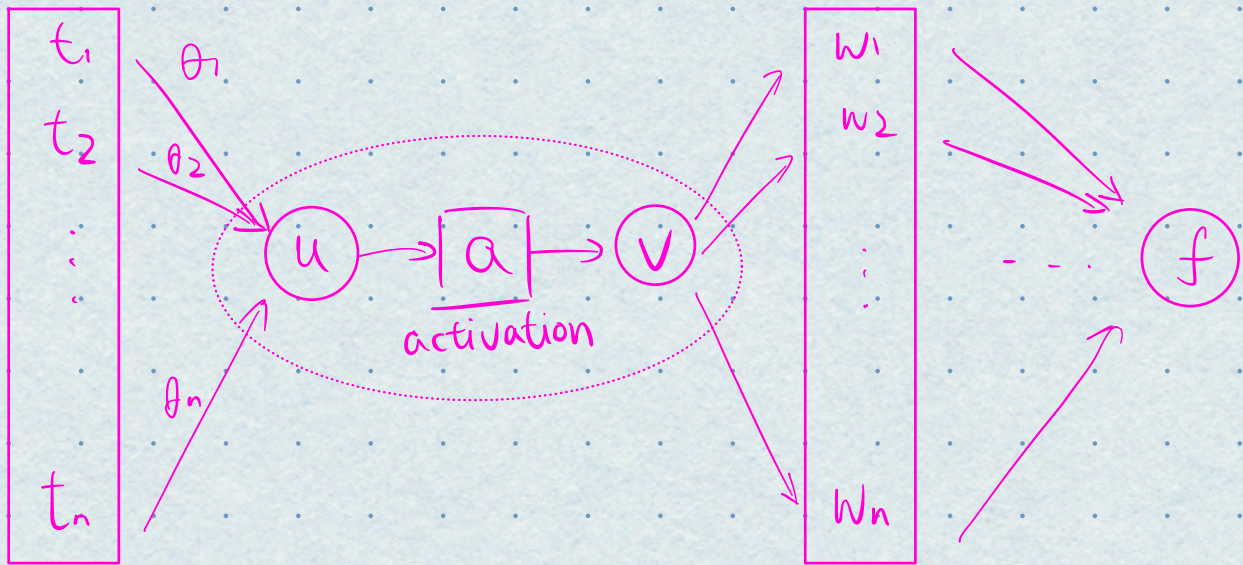


# Back propagation



$$\frac{\partial f}{\partial \theta_1} = \frac{\partial f}{\partial v} \frac{\partial v}{\partial u} \frac{\partial u}{\partial \theta_1}$$

?      $a'(\cdot)$       $t_1$

$$\frac{\partial f}{\partial v} = \sum_j \frac{\partial f}{\partial w_j} \frac{\partial w_j}{\partial v}$$

compute on  $w_j$

$$\frac{\partial f}{\partial \theta_i} = \left( \sum_j \frac{\partial f}{\partial w_j} \frac{\partial w_j}{\partial v} \right) \frac{\partial v}{\partial \theta_i} = \overbrace{\left( \sum_j \left( \sum_k \frac{\partial f}{\partial z_k} \frac{\partial z_k}{\partial w_j} \right) \frac{\partial w_j}{\partial v} \right)}^{\text{repeated terms}} \frac{\partial v}{\partial \theta_i}$$

$$\frac{\partial f}{\partial \theta_k} = \left( \sum_j \frac{\partial f}{\partial w_j} \frac{\partial w_j}{\partial v} \right) \frac{\partial v}{\partial \theta_k} = \overbrace{\left( \sum_j \left( \sum_k \frac{\partial f}{\partial z_k} \frac{\partial z_k}{\partial w_j} \right) \frac{\partial w_j}{\partial v} \right)}^{\text{repeated terms}} \frac{\partial v}{\partial \theta_k}$$