(b) $J \frac{\partial}{\partial v_c} = -\log\left(\frac{e^{u_o^T v_c}}{\sum_{w \in V_{oc}} e^{u_w^T v_c}}\right) \frac{\partial}{\partial v_c}$

$\ln(f(x)) = \frac{1}{f(x)} \cdot f'(x)$

$$= -\frac{\partial}{\partial v_c}\left[\log\left(e^{u_o^T v_c}\right) - \log\left(\Sigma e^{u_w^T v_c}\right)\right]$$

$$= -\frac{\partial}{\partial v_c}\left[u_o^T \cdot v_c\right] - \frac{1}{\sum_x e^{u_x^T v_c}} \cdot \sum_x u_x e^{u_x^T v_c}$$

$$= -u_o^T - \sum_{x \in V_{oc}}\left(\frac{e^{u_x v_c}}{\sum_{w \in V_{oc}} e^{u_w^T v_c}} \cdot u_x\right)$$

$$= -u_o^T + \sum_{x \in V_{oc}} \hat{y} \cdot u_x$$

(c) ① $-\frac{\partial}{\partial u_{w=o}} = -v_c + \frac{e^{u_o^T v_c}}{\sum_{w \in V_{oc}} e^{u_w^T \cdot v_c}} v_c$

$$= -v_c + \hat{y}_o v_c$$

② $-0 + v_c \hat{y}_w$

Add $t \neq 0$

(d) $\sigma(x) = \frac{1}{1+e^{-x}} = \frac{e^x}{e^x+1}$

$$\frac{\sigma\partial}{\partial x} = \frac{(e^x+1)e^x - e^x(e^x)}{(e^x+1)^2} = \frac{\cancel{(e^x+1)}e^x}{(e^x+1)^{\cancel{2}}} - \frac{e^{2x}}{(e^x+1)^2}$$

$$= \frac{e^x}{e^x+1} - \left(\frac{e^x}{e^x+1}\right)^2 = \sigma(x) - \sigma(x)^2$$

$$= \sigma(x) * (1 - \sigma(x))$$