



$$f_1^{L-2} = f_1^{L-1} \frac{\partial z_1^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + f_2^{L-1} \frac{\partial z_2^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \dots + f_{n_{L-1}}^{L-1} \frac{\partial z_{n_{L-1}}^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}}$$

$$f_j^{L-1} = \frac{\partial C_i}{\partial z_j^{L-1}}$$

$$f_1^{L-2} = \left[ \frac{\partial C_i}{\partial a_1^L} \frac{\partial a_1^L}{\partial z_1^L} \frac{\partial z_1^L}{\partial a_1^{L-1}} \frac{\partial a_1^{L-1}}{\partial z_1^{L-1}} \frac{\partial z_1^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \right.$$

$$\frac{\partial C_i}{\partial a_1^L} \frac{\partial a_1^L}{\partial z_1^L} \frac{\partial z_1^L}{\partial a_2^{L-1}} \frac{\partial a_2^{L-1}}{\partial z_2^{L-1}} \frac{\partial z_2^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \dots +$$

$$\left. \frac{\partial C_i}{\partial a_1^L} \frac{\partial a_1^L}{\partial z_1^L} \frac{\partial z_1^L}{\partial a_{n_{L-1}}^{L-1}} \frac{\partial a_{n_{L-1}}^{L-1}}{\partial z_{n_{L-1}}^{L-1}} \frac{\partial z_{n_{L-1}}^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} \right] + \dots +$$

$$\left[ \frac{\partial C_i}{\partial a_{n_L}^L} \frac{\partial a_{n_L}^L}{\partial z_{n_L}^L} \frac{\partial z_{n_L}^L}{\partial a_1^{L-1}} \frac{\partial a_1^{L-1}}{\partial z_1^{L-1}} \frac{\partial z_1^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \right.$$

$$\frac{\partial C_i}{\partial a_{n_L}^L} \frac{\partial a_{n_L}^L}{\partial z_{n_L}^L} \frac{\partial z_{n_L}^L}{\partial a_2^{L-1}} \frac{\partial a_2^{L-1}}{\partial z_2^{L-1}} \frac{\partial z_2^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \dots +$$

$$\left. \frac{\partial C_i}{\partial a_{n_L}^L} \frac{\partial a_{n_L}^L}{\partial z_{n_L}^L} \frac{\partial z_{n_L}^L}{\partial a_{n_{L-1}}^{L-1}} \frac{\partial a_{n_{L-1}}^{L-1}}{\partial z_{n_{L-1}}^{L-1}} \frac{\partial z_{n_{L-1}}^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} \right]$$

$$\left[ \frac{\partial c_i}{\partial a_1^L} \frac{\partial a_1^L}{\partial z_1^L} \frac{\partial z_1^L}{\partial a_1^{L-1}} \frac{\partial a_1^{L-1}}{\partial z_1^{L-1}} + \dots + \frac{\partial c_i}{\partial a_{n_L}^L} \frac{\partial a_{n_L}^L}{\partial z_{n_L}^L} \frac{\partial z_{n_L}^L}{\partial a_1^{L-1}} \frac{\partial a_1^{L-1}}{\partial z_1^{L-1}} \right] \frac{\partial z_1^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} +$$

$$\left[ \frac{\partial c_i}{\partial a_1^L} \frac{\partial a_1^L}{\partial z_1^L} \frac{\partial z_1^L}{\partial a_2^{L-1}} \frac{\partial a_2^{L-1}}{\partial z_2^{L-1}} + \dots + \frac{\partial c_i}{\partial a_{n_L}^L} \frac{\partial a_{n_L}^L}{\partial z_{n_L}^L} \frac{\partial z_{n_L}^L}{\partial a_2^{L-1}} \frac{\partial a_2^{L-1}}{\partial z_2^{L-1}} \right] \frac{\partial z_2^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \dots +$$

$$\left[ \frac{\partial c_i}{\partial a_1^L} \frac{\partial a_1^L}{\partial z_1^L} \frac{\partial z_1^L}{\partial a_{n_{L-1}}^{L-1}} \frac{\partial a_{n_{L-1}}^{L-1}}{\partial z_{n_{L-1}}^{L-1}} + \dots + \frac{\partial c_i}{\partial a_{n_L}^L} \frac{\partial a_{n_L}^L}{\partial z_{n_L}^L} \frac{\partial z_{n_L}^L}{\partial a_{n_{L-1}}^{L-1}} \frac{\partial a_{n_{L-1}}^{L-1}}{\partial z_{n_{L-1}}^{L-1}} \right] \frac{\partial z_{n_{L-1}}^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}}$$

$$= \int_1^{L-1} \frac{\partial z_1^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \int_2^{L-2} \frac{\partial z_2^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}} + \dots + \int_{n_{L-1}}^{L-1} \frac{\partial z_{n_{L-1}}^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}}$$

$$= \sum_{k=1}^{n_{L-1}} \int_k^{L-1} \frac{\partial z_k^{L-1}}{\partial a_1^{L-2}} \frac{\partial a_1^{L-2}}{\partial z_1^{L-2}}$$

$$\cancel{z_k^{L-1}} = \sum_{m=1}^{n_{L-1}} w_{km}^{L-1} a_m^{L-2} + b_k^{L-1}$$

$$a_1^{L-2} = \sigma(z_1^{L-2})$$

$$= \sum_{k=1}^{n_{L-1}} \int_k^{L-1} w_{k1}^{L-1} \sigma'(z_1^{L-2})$$

$$\Rightarrow \int_j^{L-2} = \sum_{k=1}^{n_{L-1}} \int_k^{L-1} w_{kj}^{L-1} \sigma'(z_j^{L-2})$$

$$\Rightarrow \int^{L-2} = [(W^{L-1})^T \int^{L-1}] \odot \sigma'(z^{L-2})$$

want:  $\int_j^L = \frac{\partial c_i}{\partial z_j^L}$