

$$\frac{\partial \mathcal{L}}{\partial [U_k]_{i,j}} = \sum_{l=1}^{NL} \text{Tr} \left[ \frac{\partial \log p(x^l, v^l, g^l \mid U_{1\dots K})}{\partial C_v^l} \frac{\partial C_v^l}{\partial [U_k]_{i,j}} \right]$$