

$$\begin{array}{c} n_1 \text{ cells} \end{array}
 \begin{array}{c} g + z_1 \text{ features} \end{array}
 \begin{array}{c} k \text{ factors} \end{array}
 \begin{array}{c} \begin{array}{cc} E_1 & P_1 \end{array} \approx \begin{array}{c} H_1 \end{array} \times \left( \begin{array}{cc} \begin{array}{c} V_1 \\ + \\ W \end{array} & \begin{array}{c} U_1 \\ \\ O \end{array} \end{array} \right)$$

$$\begin{array}{c} n_2 \text{ cells} \end{array}
 \begin{array}{c} g + z_2 \text{ features} \end{array}
 \begin{array}{c} k \text{ factors} \end{array}
 \begin{array}{c} \begin{array}{cc} E_2 & P_2 \end{array} \approx \begin{array}{c} H_2 \end{array} \times \left( \begin{array}{cc} \begin{array}{c} V_2 \\ + \\ W \end{array} & \begin{array}{c} U_2 \\ \\ O \end{array} \end{array} \right)$$

where  $z_i$  is the number of unshared features

$$\arg \min_{H^i \geq 0, W \geq 0, V^i \geq 0, U^i \geq 0} \sum_i^d \left\| (E^i P^i) - H^i ((W \ 0) + (V^i U^i)) \right\|_F^2 + \lambda_i \sum_i^d \left\| H^i (V^i U^i) \right\|_F^2$$