

$$\sum_{(u, i) \in S_1} \left(r_{u,i} - \mu + b_u + b_i + q_i^T \left(p_u + |N_u|^{-\frac{1}{2}} \sum_{j \in N_u} y_j \right) \right)^2 + \lambda \left(b_u^2 + b_i^2 + \|q_i\|^2 + \|p_u\|^2 + \sum_{j \in N_u} \|y_j\|^2 \right) \quad (1)$$

$$\sum_{(u, i) \in S_2} \left(r_{u,i} - \mu + b_u + b_i + q_i^T \left(p_u + |N_u|^{-\frac{1}{2}} \sum_{j \in N_u} y_j \right) \right)^2 + \lambda \left(b_u^2 + b_i^2 + \|q_i\|^2 + \|p_u\|^2 + \sum_{j \in N_u} \|y_j\|^2 \right) \quad (2)$$