Algorithm 1 Algorithm for dictionary learning under global sparsity constraint (GDL)

Given: The input data $\mathbf{X} = [\mathbf{x}_1, \cdots, \mathbf{x}_n] \in R^{d \times n}$, the global sparsity K

Execute:

1. Initialize the dictionary $\mathbf{D} \in R^{d \times m}$ and the coefficient matrix $\mathbf{A} \in R^{m \times n}$ with sparsity K, respectively.
2. Repeat
   2.1 (Column updating). Update the column vector $\mathbf{a}_i^c$ of $\mathbf{A}$ by solving (**??**) for each $i = 1, \cdots, n$.
   2.2 (Row updating). Update the row vector $\mathbf{a}_i^r$ of $\mathbf{A}$ and the atom $\mathbf{d}_i$ of $\mathbf{D}$ by solving (**??**) for each $i = 1, \cdots, m$.

   Until the termination condition is satisfied

Return: the solution **D, A** of (P_K).