**Input :** $\lambda_2; v_p = v^{(i,j)}, R^{(i)}, S^{(j)}, \ \forall\, 0 \leqslant i < j \leqslant T$

**Output:** $w_p = w^{(i,j)}, \ \forall\, 0 \leqslant i < j \leqslant T$

**Algorithm** `2D Fused Lasso()`

- **Define** $d(p, p')$ as distance from $p$ to $p'$
- **Define** $D(k, k') = \min_{\substack{p \in G_k \\ p' \in G'_k}} d(p, p')$
- **Define** $c_{k,k'} = \sum_{p \in G_k} \sum_{p' \in G'_k} I[d(p, p') = 1]$
- **Define** $N_k = |G_k|$
- **Define** $\overline{w_k} = \frac{1}{N_k} \sum_{p \in G_k} w_p$
- **Define** $\gamma_k$ as the agreed value in $G_k$
- **Init** $G$: $w_p \in G_p$
- **while** $w^{(i,j)}$ *not converge* **do**
  - `Descent Cycle`
  - `Fusion Cycle`
  - `Smoothing Cycle`
- **end**

**Procedure** `Descent Cycle`

Iteratively consider derivatives of $\gamma_k$ only and fix all other parameters:

$$N_k \cdot (\overline{w_k} - \gamma_k) + \lambda_2 \cdot \sum_{D(k,k')=1} c_{k,k'} \cdot \operatorname{sgn}(\gamma_k - \gamma'_k).$$

Update $\gamma_k$ if the model cost reduces.

**Procedure** `Fusion Cycle`

Iteratively consider to merge $G_k$ and $G'_k$, where $D(k, k') = 1$, and fix all other parameters:

$$N_k \cdot (\overline{w_k} - \gamma_k) + N'_k \cdot (\overline{w'_k} - \gamma'_k) + \lambda_2 \cdot \sum_{D(k,l)=1} c_{k,l} \cdot \operatorname{sgn}(\gamma_k - \gamma_l) + \lambda_2 \cdot \sum_{D(k',l)=1} c_{k',l} \cdot \operatorname{sgn}(\gamma'_k - \gamma_l).$$

If model cost reduces by merging $G_k$ and $G'_k$, we introduce a new group $G_m = G_k \bigcup G'_k$, with $N_m = N_k + N'_k$, $\overline{w_m} = (N_k \overline{w_k} + N'_k \overline{w'_k})/N_m$, and $c_{m,l} = c_{k,l} + c_{k',l}$.

**Procedure** `Smoothing Cycle`

To prevent model from stucking at local optimal, increase $\lambda_2$ with slightly, i.e. $\lambda_2 \leftarrow \lambda_2 + \delta$.