

EEG CHANNEL OPTIMIZATION VIA SPARSE COMMON SPATIAL FILTER

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Motivation of Proposed Algorithm

- For online BCI, it is desirable to quickly respond to input signals.
- Using a large number of channels indicates a slow response and a large computational cost.

Traditional Common Spatial Pattern (CSP)

$$\max_{\mathbf{w} \in \mathbb{R}^N} \frac{\mathbf{w}^T \mathbf{C}_1 \mathbf{w}}{\mathbf{w}^T \mathbf{C}_2 \mathbf{w}} \quad (1)$$

The Proposed Algorithm

- Firstly, to ensure that the performance of CSP is not be severely affected, the following optimization problem is formulated in the proposed algorithm as

$$\min_{\mathbf{w} \in \mathbb{R}^N} \|\mathbf{w}\| \quad (2)$$

$$\text{s.t. } \frac{\mathbf{w}^T \mathbf{C}_1 \mathbf{w}}{\mathbf{w}^T \mathbf{C}_2 \mathbf{w}} \geq \rho \cdot \tau$$

- Secondly, introducing $\mathbf{W} = \mathbf{w}\mathbf{w}^T$ and relaxing the equality constraint to a linear matrix inequality (LMI) constraint $\mathbf{W} \geq \mathbf{0}$ (\mathbf{W} is a positive

semidefinite matrix).

$$\min_{\mathbf{W} \in \mathbb{R}^N} \|\mathbf{W}\|_{1,1} \quad (3)$$

$$\text{s.t. } \frac{\text{Tr}(\mathbf{C}_1 \mathbf{W})}{\text{Tr}(\mathbf{C}_2 \mathbf{W})} \geq \rho \cdot \tau$$

$$\mathbf{W} \geq \mathbf{0}$$

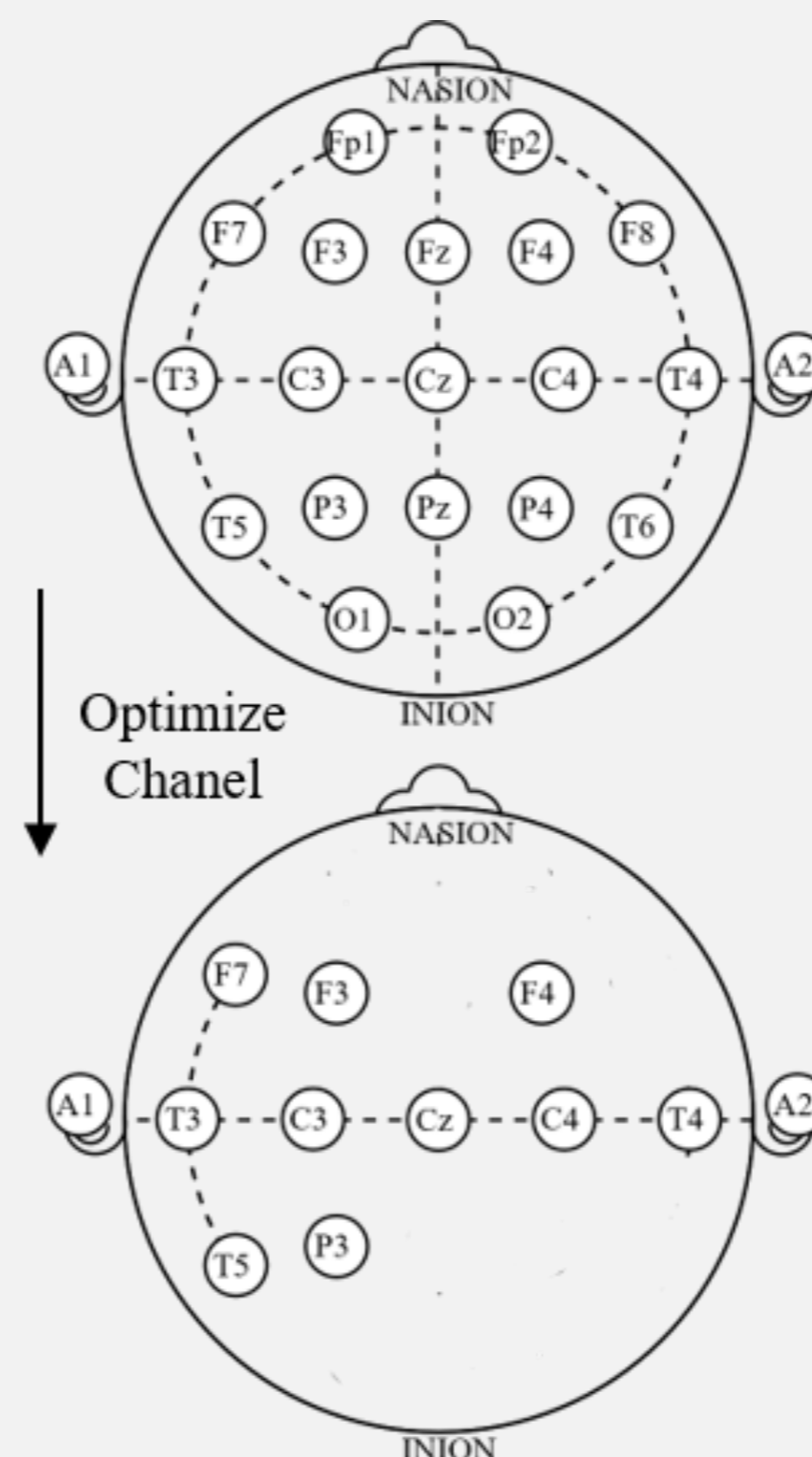
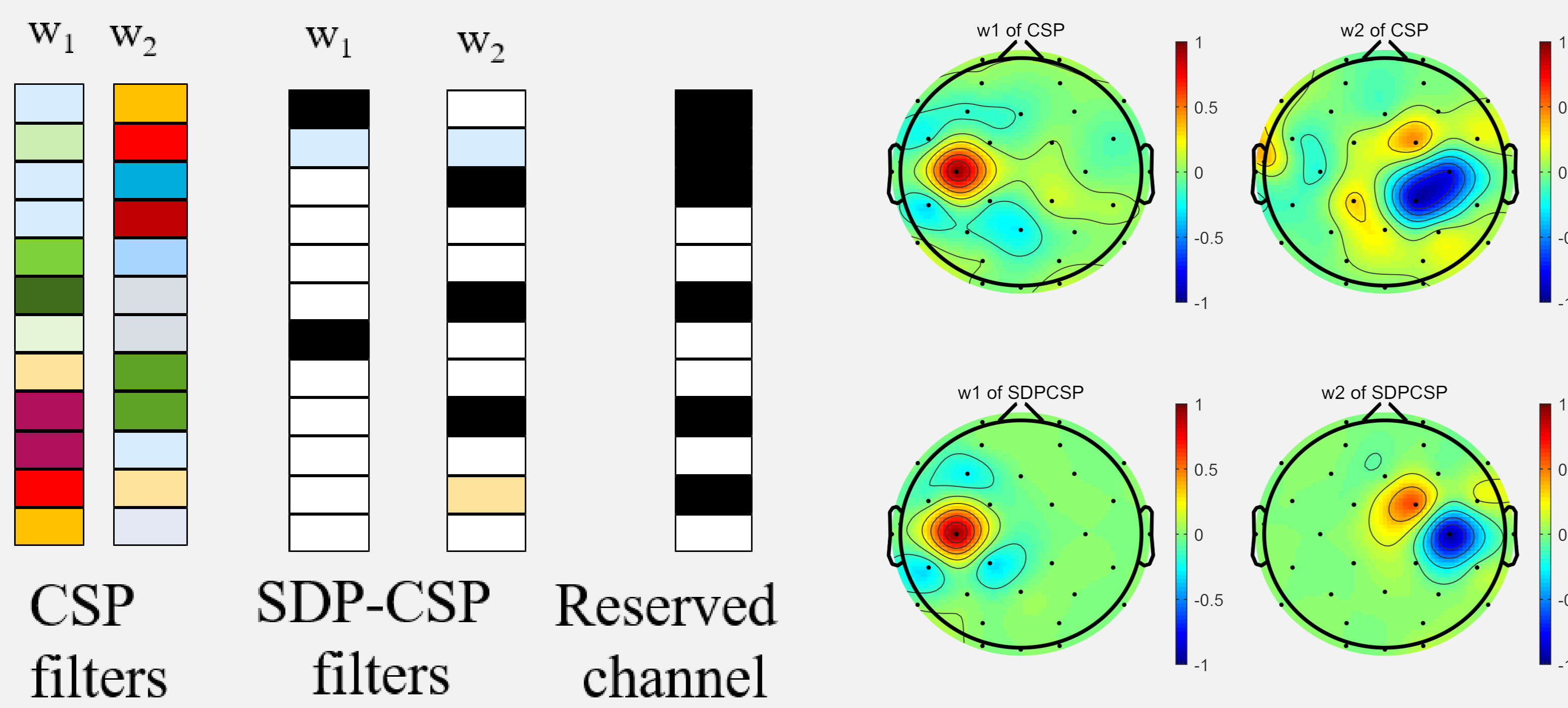
$$\text{Tr}(\mathbf{W}) = 1$$

where

$$\|\mathbf{W}\|_{1,1} = \sum_i \|\mathbf{w}_{i,:}\|_1 \quad (4)$$

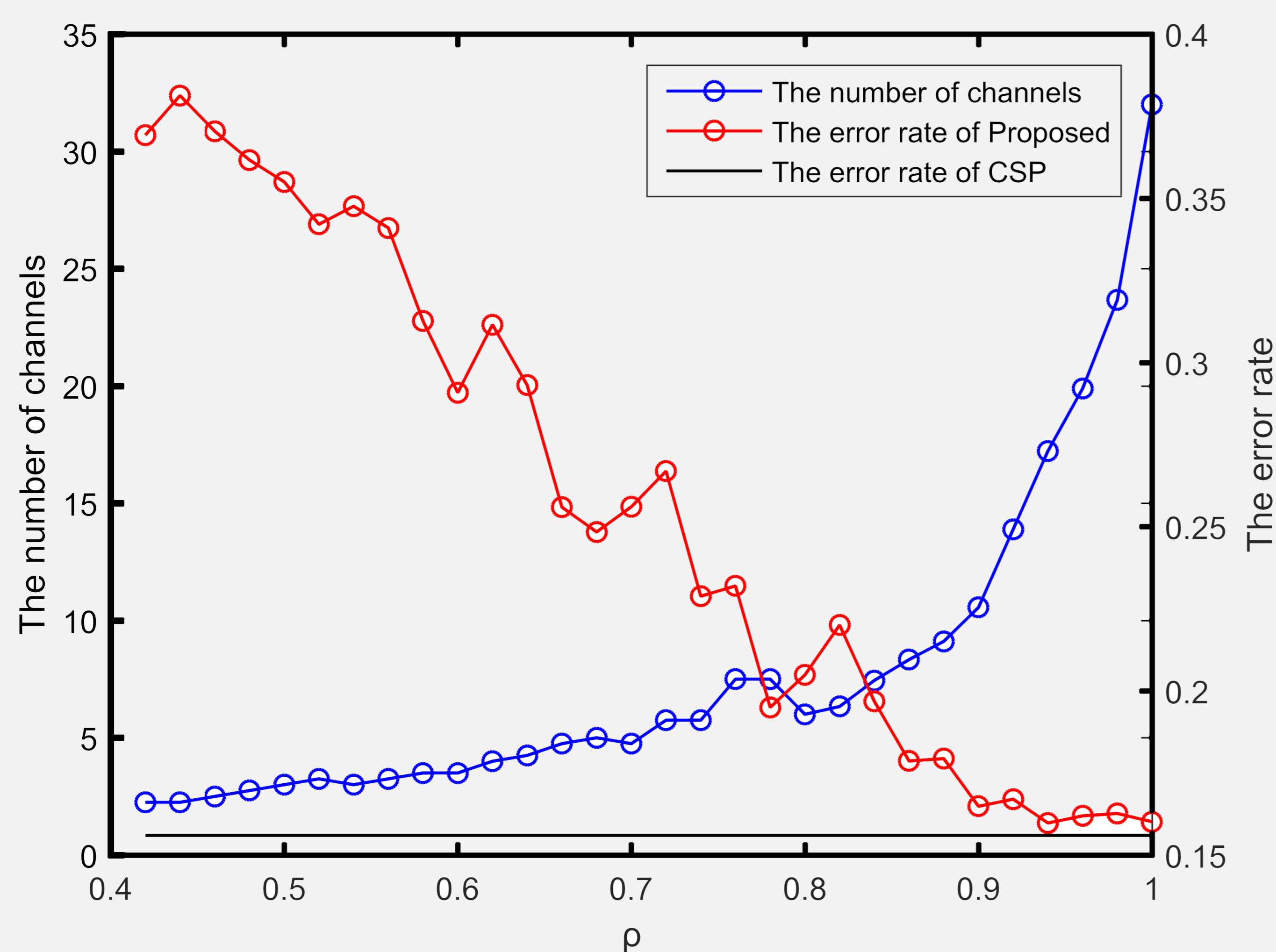
- Finally, channels is discarded when corresponding element are zero in both two filters.

Channel Optimization

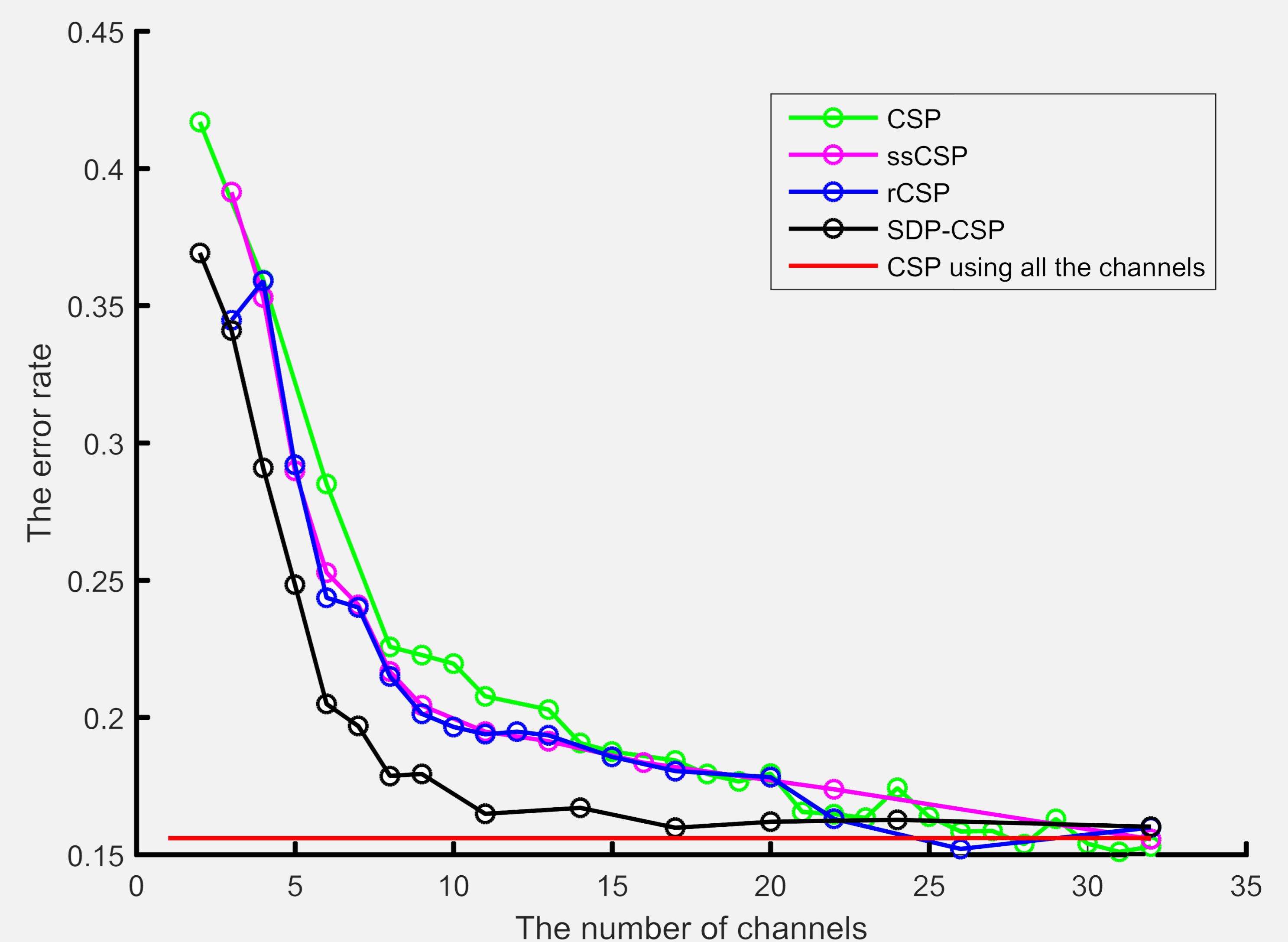


- The left figure shows the process of channels selection.
- The middle figure shows that filters obtained by SDPCSP are sparser than those obtained by traditional CSP.
- The right figure shows the result of channel optimization.

The Effect of Parameter ρ



The Performance Of Proposed Algorithm



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