Minimax Localization of Structural Information in Large Noisy Matrices

Poster: W055

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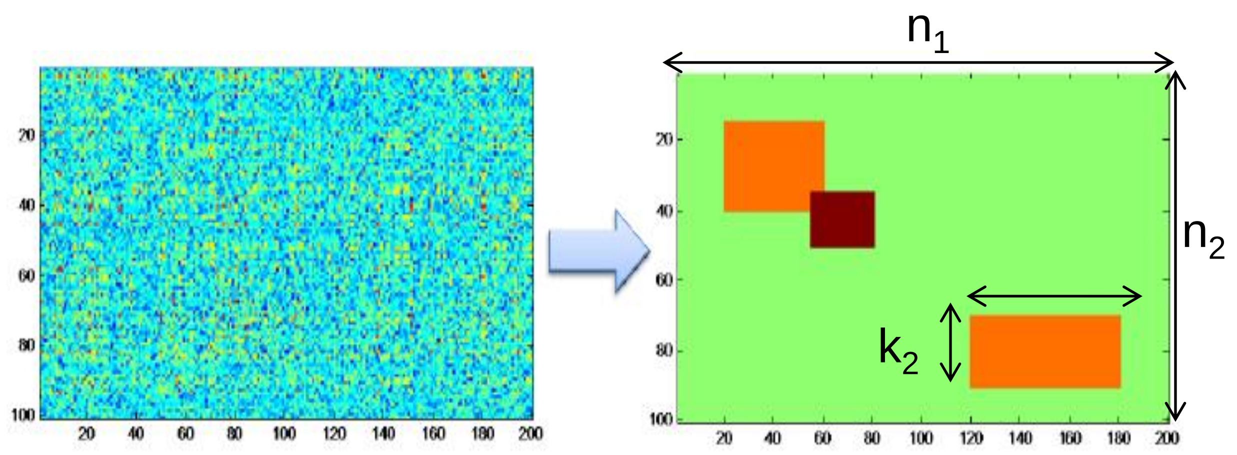
Identifying biclusters



Goal: De-noise and re-order rows/columns of the matrix to infer biclusters that are activated.

Observation model

$\mathbf{A} = \beta \mathbf{u}\mathbf{v}^T + \mathbf{R}$

$\mathbf{u}$ – k_1 sparse unit vector

$\mathbf{v}$ – k_2 sparse unit vector

$\mathbf{u},\mathbf{v} \propto \{-1,0,1\}$

$\mathbf{R}$ ~ i.i.d. zero-mean subgaussian(σ^2) perturbation

Identifying biclusters

<u>Information Theoretic minimax limit:</u> If

$$\text{SNR} \qquad \frac{\beta}{\sigma} \sim \sqrt{\frac{k_1 k_2 \log(n_1 n_2)}{\min(k_1, k_2)}}$$

then, for **any** biclustering procedure, the probability of failure remains bounded away from zero by a constant.

<u>Note:</u>

Optimal performance achieved by scanning over all submatrices of size k_1 x k_2.

Computationally efficient procedures

SNR

Elementwise thresholding

Sparse Singular Value Decomposition

$$\frac{\beta}{\sigma} \sim \sqrt{k_1 k_2 \log(n_1 n_2)}$$

Row/Column Averaging

(large clusters only $k \sim n^{1/2+\alpha}$)

$$\frac{\beta}{\sigma} \sim \frac{\sqrt{k_1 k_2 \log(n_1 n_2)}}{\min(n_1^\alpha, n_2^\alpha)}$$

Note:

These procedures do not achieve information theoretic lower bound.