Optimal Sensor and Actuator Selection in Large-Scale Dynamic Networks

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Motivation

Challenging in large-scale systems

- Heterogenous robotic networks
- Phasor Measurement Units in power networks
Problem Formulation

Linear dynamical system with many potential actuators

\[
\dot{x} = Ax + B_1 d + B_2 u
\]
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Linear dynamical system with many potential actuators

\[ \dot{x} = Ax + B_1d + B_2u \]

Objective: identify row-sparse state-feedback controller

minimize \[ J(K) \] + \[ \gamma \sum_i \|e_i^T K\|_2 \]

↓

performance index \hspace{2cm} row-sparsity-promoting penalty function

Challenge: \( J(K) \) – non-convex function of \( K \)
Solution

Change of variables $Y := K X$

- **Convex dependence** of $J(K)$ on $X$ and $Y$
- Row-sparse **structure preserved**

\[
\begin{align*}
    u &= -Kx \\
    &= -Yx \\
    X^{-1} &= X
\end{align*}
\]
Solution

Change of variables \( Y := KX \)

- **Convex dependence** of \( J(K) \) on \( X \) and \( Y \)
- Row-sparse **structure preserved**

\[
\begin{align*}
\mathbf{u} &= - \mathbf{K} \quad & \mathbf{x} \quad & \mathbf{Y} \\
\quad &= - \quad & \mathbf{X^{-1}} \quad & \mathbf{x}
\end{align*}
\]

Optimization problem

- **Semidefinite program**

Key contribution

- **An efficient algorithm for large-scale networks**