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Decentralized Control for Asymmetric Information Sharing Patterns

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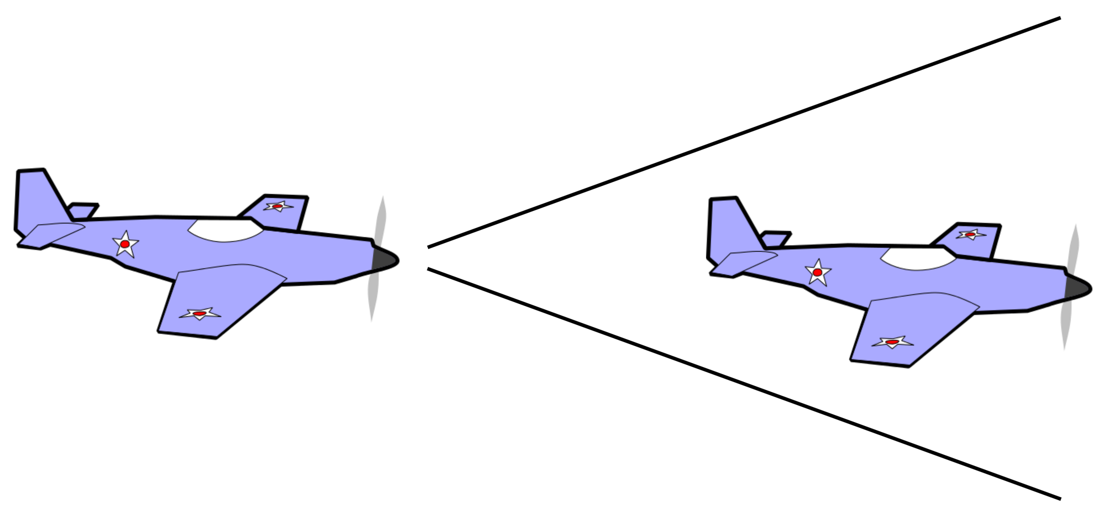
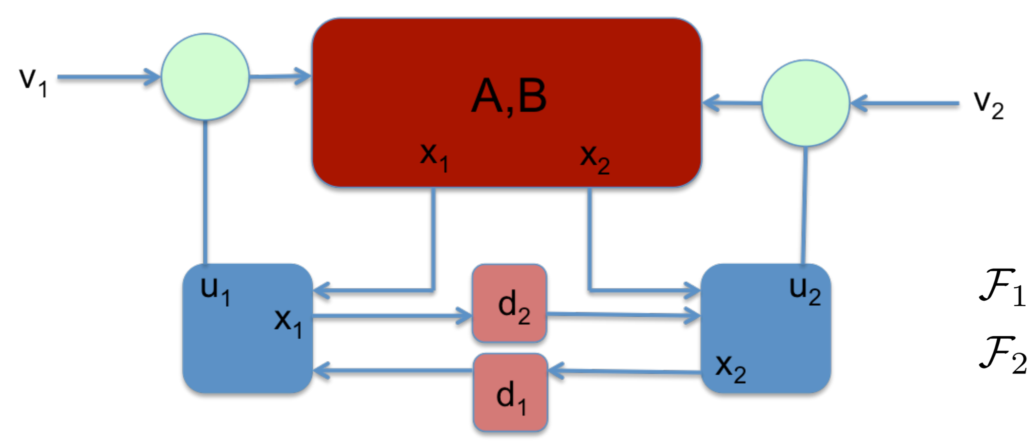
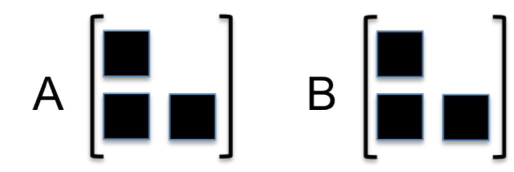
Motivation



Team problem – Common objective but different information

Delayed Information Sharing





Plant Structure

$\mathcal{F}_1(t) = \{x_1(0:t), u_1(0:t-1)\}$

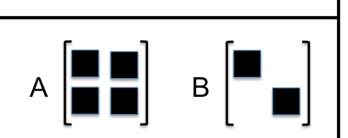
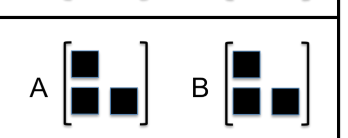
$\mathcal{F}_2(t) = \{x_1(0:t-1), u_1(0:t-1), x_2(0:t), u_2(0:t-1)\}$

Information Pattern

$$u^*(t) = \arg\min_{u(t)} \mathbb{E}[\sum_{t=0}^{N-1}(x(t)'Qx(t) + u(t)'Ru(t)) + x(N)'Sx(N)]$$

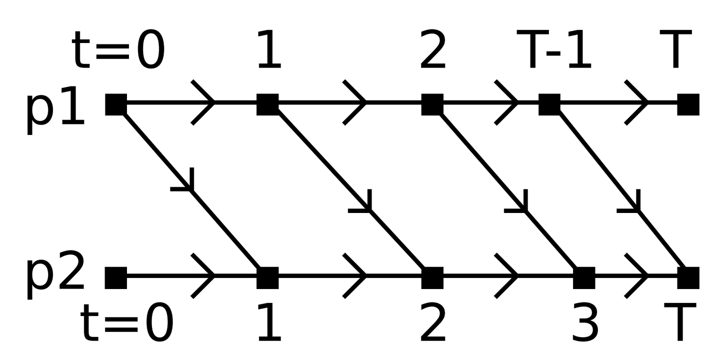
Objective Function

Comparison

d_1	d_2	Literature	Comments
0	0	Classical LQR	No plant restrictions
1	1	Kurtaran, Sandell, Yoshikawa	No plant restrictions
1	1	Lamperski and Doyle	
∞	0	Lall et al.	
1	0	Our previous work	No plant restrictions

Current work: $(\infty, 1)$

Linearity



Partially nested structure

i's information is affected by j's decision => j's information is subset of i's information

Sufficient condition for existence of linear optimal control law

Statistics

$\mathcal{H}_i(t) = \{x_i(0:t-1), u_i(0:t-1)\}$

Observation history

$\hat{x}(t) := \mathbb{E}[x(t)|\mathcal{H}_1(t)]$

$\hat{\hat{x}}(t) := \mathbb{E}[x(t)|\mathcal{H}_1(t), \mathcal{H}_2(t)]$

Statistics

$\overline{x}(t) = \begin{bmatrix}\hat{x}_1(t) \\ \hat{\hat{x}}_2(t)\end{bmatrix}$

Summary statistics – compress space of laws

Optimal Control Law

$$u^*(t) = \begin{bmatrix} F^*_{11}(t) & 0 \\ 0 & F^*_{22}(t)\end{bmatrix}\begin{bmatrix} x_1(t) - \hat{x}_1(t) \\ x_2(t) - \hat{x}_2(t)\end{bmatrix} - \begin{bmatrix} K_{11}(t) & K_{12}(t) & 0 \\ K_{21}(t) & K_{22}(t) & J(t)\end{bmatrix}\begin{bmatrix}\hat{x}_1(t) \\ \hat{x}_2(t) \\ \hat{\hat{x}}_2(t) - \hat{x}_2(t)\end{bmatrix}$$

$F^*(t)$ is optimal gain matrix, obtained as a solution to a deterministic convex optimization problem

K(t) and J(t) are solutions to algebraic Riccati equations

Future Work

Extended to partial output feedback

Multiple-unit delays

Stochastic games

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