

system id

$$y[n] = -a_1 y[n-1] - \dots - a_P y[n-P] + b_0 x[n] + b_1 x[n-1] + \dots + b_Q x[n-Q]$$

x, y, P, Q are given

$$L = \max(P, Q);$$

$$N = \text{length}(x);$$

$$y_{\text{firstcolumn}} = y(L:(N-1));$$

$$y_{\text{firstrow}} = y(L:(-1):(L-P+1));$$

$$Y = \text{toeplitz}(y_{\text{firstcolumn}}, y_{\text{firstrow}});$$

$$y_{\text{vec}} = y((L+1):N);$$

$$\begin{aligned} x_{\text{firstcolumn}} &= x((L+1):N); \\ x_{\text{firstrow}} &= x((L+1):(-1):(L-Q+1)); \\ X &= \text{toeplitz}(x_{\text{firstcolumn}}, \\ &\quad x_{\text{firstrow}}); \\ D &= [-Y \quad X]; \\ \text{theta} &= \text{pinv}(D) * y_{\text{vec}}; \\ a &= \text{theta}(1:P); \\ A &= [1; a]; \\ B &= \text{theta}((P+1):(P+Q+1)); \end{aligned}$$

FIR system FD

same except $p=0$ so ignore Y

$$L = Q;$$

$$D = X;$$

$$\text{theta} = \text{pinv}(D) * \text{yvec};$$

$$B = \text{theta};$$

$$A = 1;$$