

# Sketchy Lyapunov and Sylvester equations

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## Abstract

## 1 Sylvester matrix equation

Consider the equation

$$\mathbf{A}\mathbf{X} - \mathbf{X}\mathbf{B} = \mathbf{F}, \tag{1}$$

where  $\mathbf{A}, \mathbf{B}$  and  $\mathbf{F}$  are given matrices and  $\mathbf{X}$  and unknown matrix, all of appropriate dimensions.

By vectorizing

**Rob:** *My guess on ADI method*

### 1.1 Rob's naive guess on the ADI method

### 1.2 Constrained random subspace algorithm

$$\begin{aligned} \mathbf{S}^t &\sim \mathcal{D} \\ \mathbf{X}^{t+1} &= \arg \min \|\mathbf{A}\mathbf{X} - \mathbf{X}\mathbf{B} - \mathbf{F}\|_F^2 \\ &\text{subject to } \mathbf{X} = \mathbf{X}^t + \mathbf{S}^t \mathbf{Y}^\top, \quad \mathbf{Y} \text{ free.} \end{aligned} \tag{2}$$

We might try a different weighted Frobenius norm.

**Rob:** *Is solving (2) equivalent to solving a small scale Sylvester equation?*