Lecture 29

- Any Relationship between $\begin{bmatrix} 0 & B \\ B^T & 0 \end{bmatrix}$ and $\begin{bmatrix} I & A \\ A^T & 0 \end{bmatrix}$? ✓
- Why does V look like $\begin{bmatrix} \underline{x_1} & 0 & \underline{x_2} & 0 & \\ 0 & y_1 & 0 & y_2 & \cdots \end{bmatrix}$
- Is Arnoldi more Expensive than Lanczos at Each step? ✓ → Yes! Need to Compute all coeffs in H_k.

- GMRES vs slower MINRES (why? Arn Lanczos?) ✓ ✓
- Restart of GMRES vs. ✓ Restart of MINRES
- Time Complexity of SVD?

than

ldi: vs

$A: m \times n, \quad m > n$

SVD in .

$O\left((m+n)^3\right)$ via

λ-vals on $\begin{bmatrix} 0 & A \\ A^T & 0 \end{bmatrix}$

$O\left(\min(m,n)^3\right)$ via

λvals$(\underset{\nwarrow mn^2}{A^TA}$ or $AA^T.)$

or $\boxed{O(mn^2).}$

We "never" restart MINRES

(or I'm not aware of it!).

$$A = \begin{bmatrix} 0 & B \\ B^T & 0 \end{bmatrix}$$

$$\underline{x}_0 = \begin{bmatrix} \underline{x}_1 \\ \hline 0 \end{bmatrix} \text{ then}$$

$$A\underline{x}_0 = \begin{bmatrix} 0 \\ B\underline{x}_1 \end{bmatrix}$$

$$A^2 \underline{x}_0 = \begin{bmatrix} B^T B x_1 \\ 0 \end{bmatrix}$$

$$A^3 \underline{x}_0 = \begin{bmatrix} 0 \\ B B^T B x_1 \end{bmatrix}$$

$$A^+ = \lim_{\lambda \to 0} (A^T A +$$

T

$$x(\lambda) = \min \|b - Ax\|_2^2 + \lambda$$

$$\lim_{\lambda \to 0^+} x(\lambda) = A^+$$

$\lambda I)^{-1} A^T$

$\|x\|_2^2 \longrightarrow (A^TA + \lambda I)x = A^T\underline{b}$

$- \underline{b}$

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