

# EECS 16B CSM

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# SVD

# Definition

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$$\mathbf{A} = \sum_{i=1}^r \sigma_i \mathbf{u}_i [\mathbf{v}_i]^\top = \mathbf{U} \mathbf{\Sigma} [\mathbf{V}]^\top = \begin{bmatrix} \mathbf{u}_1 & \mathbf{u}_2 & \cdots & \mathbf{u}_r \end{bmatrix} \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \sigma_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_n \end{bmatrix} \begin{bmatrix} [\mathbf{v}_1]^\top \\ [\mathbf{v}_2]^\top \\ \vdots \\ [\mathbf{v}_n]^\top \end{bmatrix} \quad (1)$$

- $\mathbf{U}$ : orthonormal matrix
- $\mathbf{\Sigma}$ : diagonal matrix
- $[\mathbf{V}]^\top$ : orthonormal matrix

# Applications

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- PCA
- least squares, pseudoinverse
- splitting up matrix operations

# Visualization

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