

Additional Notes and Solution Manual For: Matrix Computations: Third Edition by Gene H. Golub and Charles F. Van Loan

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Chapter 2 (Matrix Analysis):

Basic Ideas from Linear Algebra

P 2.1.1 (existence of a p rank factorization of A)

Assume A is $m \times n$ and of rank r . The using elementary elimination matrices we can reduce A to its row reduced echelon form R , given by $E_1 A = R$ or $A = E_1^{-1} R = E_2 R$. In this reduction E_2 is $m \times m$ and R is $m \times n$. Because R has $n - r$ zero rows we can block decompose it as follows

$$R = \begin{bmatrix} \hat{R}_{r \times n} \\ 0_{m-r \times n} \end{bmatrix}$$

where we have listed the dimensions of the the block matrices next to them. Now \hat{R} is of rank r . In addition, block decomposing E_2 as

$$E_2 = \begin{bmatrix} \hat{E}_{m \times r} & \hat{E}_{m \times m-r} \end{bmatrix}.$$

Now since E_2 is of rank m the first r columns of E_2 is a matrix of rank r . This block decomposition gives for A the expression

$$A = \begin{bmatrix} \hat{E} & \hat{E} \end{bmatrix} \begin{bmatrix} \hat{R} \\ 0 \end{bmatrix} = \hat{E} \hat{R}$$

This gives the decomposition of A into \hat{E} of size $m \times r$ and \hat{R} of size $r \times n$ each of rank r , thus proving the decomposition.

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Golub And Van Loan Solution Manual

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