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# Complete pivoting strategy to compute the IULBF preconditioner

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**Abstract**

In this paper, a complete pivoting strategy to compute the IULBF preconditioner is presented.

**Keywords:** pivoting, IULBF preconditioner.
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## 1 Introduction

Consider the linear system of equations of the form $Ax = b$, where the coefficient matrix $A \in \mathbb{R}^{n\times n}$ is nonsingular, large, sparse and nonsymmetric and also $x, b \in \mathbb{R}^n$. An $IUL$ preconditioner $M$ for this system is in the form of $M = UDL \approx A$. This preconditioner will change the original system to the left preconditioned system $M^{-1}Ax = M^{-1}b$. For a proper preconditioner, instead of solving the original system, it is better to solve the left preconditioned system by the Krylov subspace methods [4]. In [1, 2], we have proposed an $IUL$ preconditioner for system $Ax = b$. This preconditioner is termed the $IULBF$.

**Algorithm 1** ( IULBF preconditioner )

**Input:** $A \in \mathbb{R}^{n\times n}$ and $\tau_z, \tau_w, \tau_l, \tau_u \in (0,1)$ be drop tolerances parameters.
**Output:** $A \approx UDL$

**for** $i = n$ to 1 **do**
  $w_i^{(0)} = e_i^T$, $z_i^{(0)} = e_i$.
  **for** $j = i+1$ to $n$ **do**
    $p_j^{(i-1)} = e_i^T A z_j^{(n-j)}$   $q_j^{(i-1)} = w_j^{(n-j)} A e_i$
    $U_{ij} = \frac{p_j^{(i-1)}}{d_{jj}}$, $L_{ji} = \frac{q_j^{(i-1)}}{d_{jj}}$
    If $|L_{ji}| < \tau_l$, then set $L_{ji} = 0$. Also if $|U_{ij}| < \tau_u$, then set $U_{ij} = 0$
    $z_i^{(j-i)} = z_i^{(j-i-1)} - \frac{q_j^{(i-1)}}{d_{jj}} z_j^{(n-j)}$, $w_i^{(j-i)} = w_i^{(j-i-1)} - \frac{p_j^{(i-1)}}{d_{jj}} w_j^{(n-j)}$
    For all $l \geq j$, if $|z_{li}^{(j-i)}| < \tau_z$ and $|w_{il}^{(j-i)}| < \tau_w$, then set $z_{li}^{(j-i)} = 0$ and $w_{il}^{(j-i)} = 0$
  **end for**
  $d_{ii} = w_i^{(n-i)} A e_i$
**end for**
Return $U = (U_{ij})_{1\leq i,j\leq n}$, $D = diag(d_{ii})_{1\leq i\leq n}$ and $L = (L_{ji})_{1\leq j,i\leq n}$.

Algorithm 1, computes the $IULBF$ preconditioner. In this algorithm, matrices $L$ and $U$ are computed column-wise and row wise, respectively.

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