

Step	Algorithm: $A := \text{LU_UNB_VAR3}(A)$
1a	$\{A = \hat{A}$
4	$A \rightarrow \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right), L \rightarrow \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right), U \rightarrow \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right)$ <p>where A_{TL} is 0×0, L_{TL} is 0×0, U_{TL} is 0×0</p>
2	$\left\{ \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \right\}$
3	while $m(A_{TL}) < m(A)$ do
2,3	$\left\{ \begin{array}{l} \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \wedge m(A_{TL}) < \\ m(A) \end{array} \right\}$
5a	$\left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c cc} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \rightarrow \dots, \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \rightarrow \dots$ <p>where α_{11} is 1×1, λ_{11} is 1×1, v_{11} is 1×1</p>
6	$\left\{ \begin{array}{l} \left(\begin{array}{ccc} A_{00} & a_{01} & A_{02} \\ a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right) = \left(\begin{array}{ccc} L \setminus U_{00} & u_{01} & U_{02} \\ \hat{a}_{10}^T & \hat{\alpha}_{11} & \hat{a}_{12}^T \\ \hat{A}_{20} & \hat{a}_{21} & \hat{A}_{22} \end{array} \right) \\ \wedge L_{00}U_{00} = \hat{A}_{00} \quad L_{00}u_{01} = \hat{a}_{01} \quad L_{00}U_{02} = \hat{A}_{02} \end{array} \right\}$
8	$a_{10}^T := l_{10}^T = \hat{a}_{10}^T U_{00}^{-1} = a_{10}^T U_{00}^{-1} \quad (U_{00} \text{ is stored in the upper triangular part of } A_{00})$ $\alpha_{11} := v_{11} = \hat{\alpha}_{11} - l_{10}^T u_{01} = \alpha_{11} - a_{10}^T a_{01}$ $a_{12}^T := u_{12}^T = \hat{a}_{12}^T - l_{10}^T U_{02} = a_{12}^T - a_{10}^T A_{02}$
7	$\left\{ \begin{array}{l} \left(\begin{array}{ccc} A_{00} & a_{01} & A_{02} \\ a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right) = \left(\begin{array}{ccc} L \setminus U_{00} & u_{01} & U_{02} \\ l_{10}^T & v_{11} & u_{12}^T \\ \hat{A}_{20} & \hat{a}_{21} & \hat{A}_{22} \end{array} \right) \\ \wedge L_{00}U_{00} = \hat{A}_{00} \quad L_{00}u_{01} = \hat{a}_{01} \quad L_{00}U_{02} = \hat{A}_{02} \\ l_{10}^T U_{00} = \hat{a}_{10}^T \quad l_{10}^T u_{01} + v_{11} = \hat{\alpha}_{11} \quad l_{10}^T U_{02} + u_{12}^T = \hat{a}_{12}^T \end{array} \right\}$
5b	$\left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c cc} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \leftarrow \dots, \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \leftarrow \dots$
2	$\left\{ \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \right\}$
	endwhile
2,3	$\left\{ \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \wedge \neg(m(A_{TL}) < m(A)) \right\}$
1b	$\{A = L \setminus U \wedge LU = \hat{A}$

Step	Algorithm: $A := \text{LU_UNB_VAR3}(A)$
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4	
	where
2	{
3	while do
2,3	{
5a	
	where
6	{
8	
7	{
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2	{
	endwhile
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	$\neg($
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6	$\left\{ \begin{array}{l} \left(\begin{array}{ccc} A_{00} & a_{01} & A_{02} \\ a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right) = \left(\begin{array}{ccc} L \setminus U_{00} & u_{01} & U_{02} \\ \hat{a}_{10}^T & \hat{\alpha}_{11} & \hat{a}_{12}^T \\ \hat{A}_{20} & \hat{a}_{21} & \hat{A}_{22} \end{array} \right) \\ \wedge L_{00}U_{00} = \hat{A}_{00} \ L_{00}u_{01} = \hat{a}_{01} \ L_{00}U_{02} = \hat{A}_{02} \end{array} \right\}$
8	
7	$\left\{ \begin{array}{l} \left(\begin{array}{ccc} A_{00} & a_{01} & A_{02} \\ a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right) = \left(\begin{array}{ccc} L \setminus U_{00} & u_{01} & U_{02} \\ l_{10}^T & v_{11} & u_{12}^T \\ \hat{A}_{20} & \hat{a}_{21} & \hat{A}_{22} \end{array} \right) \\ \wedge L_{00}U_{00} = \hat{A}_{00} \quad L_{00}u_{01} = \hat{a}_{01} \quad L_{00}U_{02} = \hat{A}_{02} \\ l_{10}^T U_{00} = \hat{a}_{10}^T \quad l_{10}^T u_{01} + v_{11} = \hat{\alpha}_{11} \quad l_{10}^T U_{02} + u_{12}^T = \hat{a}_{12}^T \end{array} \right\}$
5b	$\left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c c} A_{00} & a_{01} \ A_{02} \\ \hline a_{10}^T & \alpha_{11} \ a_{12}^T \\ A_{20} & a_{21} \ A_{22} \end{array} \right), \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \leftarrow \dots, \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \leftarrow \dots$
2	$\left\{ \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \right\}$
	endwhile
2,3	$\left\{ \begin{array}{l} \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \wedge \neg(m(A_{TL}) < \\ m(A)) \end{array} \right\}$
1b	$\{A = L \setminus U \wedge LU = \hat{A}$

Step	Algorithm: $A := \text{LU_UNB_VAR3}(A)$
1a	$\{A = \hat{A}$
4	$A \rightarrow \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right), L \rightarrow \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right), U \rightarrow \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right)$ <p>where A_{TL} is 0×0, L_{TL} is 0×0, U_{TL} is 0×0</p>
2	$\left\{ \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \right\}$
3	while $m(A_{TL}) < m(A)$ do
2,3	$\left\{ \begin{array}{l} \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \wedge m(A_{TL}) < \\ m(A) \end{array} \right\}$
5a	$\left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c cc} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \rightarrow \dots, \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \rightarrow \dots$ <p>where α_{11} is 1×1, λ_{11} is 1×1, v_{11} is 1×1</p>
6	$\left\{ \begin{array}{l} \left(\begin{array}{ccc} A_{00} & a_{01} & A_{02} \\ a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right) = \left(\begin{array}{ccc} L \setminus U_{00} & u_{01} & U_{02} \\ \hat{a}_{10}^T & \hat{\alpha}_{11} & \hat{a}_{12}^T \\ \hat{A}_{20} & \hat{a}_{21} & \hat{A}_{22} \end{array} \right) \\ \wedge L_{00}U_{00} = \hat{A}_{00} \quad L_{00}u_{01} = \hat{a}_{01} \quad L_{00}U_{02} = \hat{A}_{02} \end{array} \right\}$
8	$a_{10}^T := l_{10}^T = \hat{a}_{10}^T U_{00}^{-1} = a_{10}^T U_{00}^{-1} \quad (U_{00} \text{ is stored in the upper triangular part of } A_{00})$ $\alpha_{11} := v_{11} = \hat{\alpha}_{11} - l_{10}^T u_{01} = \alpha_{11} - a_{10}^T a_{01}$ $a_{12}^T := u_{12}^T = \hat{a}_{12}^T - l_{10}^T U_{02} = a_{12}^T - a_{10}^T A_{02}$
7	$\left\{ \begin{array}{l} \left(\begin{array}{ccc} A_{00} & a_{01} & A_{02} \\ a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right) = \left(\begin{array}{ccc} L \setminus U_{00} & u_{01} & U_{02} \\ l_{10}^T & v_{11} & u_{12}^T \\ \hat{A}_{20} & \hat{a}_{21} & \hat{A}_{22} \end{array} \right) \\ \wedge L_{00}U_{00} = \hat{A}_{00} \quad L_{00}u_{01} = \hat{a}_{01} \quad L_{00}U_{02} = \hat{A}_{02} \\ l_{10}^T U_{00} = \hat{a}_{10}^T \quad l_{10}^T u_{01} + v_{11} = \hat{\alpha}_{11} \quad l_{10}^T U_{02} + u_{12}^T = \hat{a}_{12}^T \end{array} \right\}$
5b	$\left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c cc} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \leftarrow \dots, \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \leftarrow \dots$
2	$\left\{ \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \right\}$
	endwhile
2,3	$\left\{ \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) = \left(\begin{array}{c c} L \setminus U_{TL} & U_{TR} \\ \hline \hat{A}_{BL} & \hat{A}_{BR} \end{array} \right) \wedge L_{TL}U_{TL} = \hat{A}_{TL} \mid L_{TL}U_{TR} = \hat{A}_{TR} \wedge \neg(m(A_{TL}) < m(A)) \right\}$
1b	$\{A = L \setminus U \wedge LU = \hat{A}$

	Algorithm: $A := \text{LU_UNB_VAR3}(A)$
	$A \rightarrow \left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right), L \rightarrow \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right), U \rightarrow \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right)$ <p>where A_{TL} is 0×0, L_{TL} is 0×0, U_{TL} is 0×0</p>
	while $m(A_{TL}) < m(A)$ do
	$\left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c cc} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \rightarrow \dots, \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \rightarrow \dots$ <p>where α_{11} is 1×1, λ_{11} is 1×1, v_{11} is 1×1</p>
	$a_{10}^T := l_{10}^T = \widehat{a}_{10}^T U_{00}^{-1} = a_{10}^T U_{00}^{-1} \quad (U_{00} \text{ is stored in the upper triangular part of } A_{00})$ $\alpha_{11} := v_{11} = \widehat{\alpha}_{11} - l_{10}^T u_{01} = \alpha_{11} - a_{10}^T a_{01}$ $a_{12}^T := u_{12}^T = \widehat{a}_{12}^T - l_{10}^T U_{02} = a_{12}^T - a_{10}^T A_{02}$
	$\left(\begin{array}{c c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \leftarrow \left(\begin{array}{cc c} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \leftarrow \dots, \left(\begin{array}{c c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \leftarrow \dots$
	endwhile

Algorithm: $A := \text{LU_UNB_VAR3}(A)$

$$A \rightarrow \left(\begin{array}{c|c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right), L \rightarrow \left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right), U \rightarrow \left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right)$$

where A_{TL} is 0×0 , L_{TL} is 0×0 , U_{TL} is 0×0

while $m(A_{TL}) < m(A)$ do

$$\left(\begin{array}{c|c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c|cc} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \rightarrow \cdots, \left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \rightarrow \cdots$$

where α_{11} is 1×1 , λ_{11} is 1×1 , v_{11} is 1×1

$$a_{10}^T := l_{10}^T = \hat{a}_{10}^T U_{00}^{-1} = a_{10}^T U_{00}^{-1} \quad (U_{00} \text{ is stored in the upper triangular part of } A_{00})$$

$$\alpha_{11} := v_{11} = \hat{\alpha}_{11} - l_{10}^T u_{01} = \alpha_{11} - a_{10}^T a_{01}$$

$$a_{12}^T := u_{12}^T = \hat{a}_{12}^T - l_{10}^T U_{02} = a_{12}^T - a_{10}^T A_{02}$$

$$\left(\begin{array}{c|c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c|cc} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ A_{20} & a_{21} & A_{22} \end{array} \right), \left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \leftarrow \cdots, \left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \leftarrow \cdots$$

endwhile