

Algorithm: $y := \text{MVMULT_N_UNB_VAR1B}(A, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right)$$

where A_{TL} is 0×0 , x_T , y_T are 0×1

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

Repartition

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where α_{11} , χ_1 , and ψ_1 are scalars

$$\psi_1 := a_{10}^T x_0 + \alpha_{11} \chi_1 + a_{12}^T x_2 + \psi_1$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

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function [ y_out ] = Mvmult_unb_var1B( A, x, y )

[ ATL, ATR, ...
  ABL, ABR ] = FLA_Part_2x2( A, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                      0, 'FLA_TOP' );

while ( size( ATL, 1 ) < size( A, 1 ) )

    [ A00, a01,      A02, ...
      a10t, alpha11, a12t, ...
      A20, a21,      A22 ] = FLA_Repart_2x2_to_3x3( ATL, ATR, ...
                                                    ABL, ABR, ...
                                                    1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%
    psi1 = laff_dots( a10t, x0, psi1 );
    psi1 = laff_dots( alpha11, chi1, psi1 );
    psi1 = laff_dots( a12t, x2, psi1 );
    %-----%

    [ ATL, ATR, ...
      ABL, ABR ] = FLA_Cont_with_3x3_to_2x2( A00, a01,      A02, ...
                                              a10t, alpha11, a12t, ...
                                              A20, a21,      A22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file Mvmult_unb_var1B.m.
  Click for test script testMvmult_unb_var1B.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{MVMULT_N_UNB_VAR2B}(A, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right)$$

where A_{TL} is 0×0 , x_T, y_T are 0×1

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

Repartition

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where α_{11}, χ_1 , and ψ_1 are scalars

$$y_0 := \chi_1 a_{01} + y_0$$

$$\psi_1 := \chi_1 \alpha_{11} + \psi_1$$

$$y_2 := \chi_1 a_{21} + y_2$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Mvmult_unb_var2B( A, x, y )

[ ATL, ATR, ...
  ABL, ABR ] = FLA_Part_2x2( A, ...
                              0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                       0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                       0, 'FLA_TOP' );

while ( size( ATL, 1 ) < size( A, 1 ) )

    [ A00, a01,      A02, ...
      a10t, alpha11, a12t, ...
      A20, a21,      A22 ] = FLA_Repart_2x2_to_3x3( ATL, ATR, ...
                                                      ABL, ABR, ...
                                                      1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                     xB, ...
                                     1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                     yB, ...
                                     1, 'FLA_BOTTOM' );

    %-----%

    y0 = laff_axpy( chi1, a01, y0 );
    psi1 = laff_axpy( chi1, alpha11, psi1 );
    y2 = laff_axpy( chi1, a21, y2 );

    %-----%

    [ ATL, ATR, ...
      ABL, ABR ] = FLA_Cont_with_3x3_to_2x2( A00, a01,      A02, ...
                                              a10t, alpha11, a12t, ...
                                              A20, a21,      A22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file Mvmult_unb_var2B.m.
  Click for test script test.Mvmult_unb_var2B.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{MVMULT_T_UNB_VAR1}(A, x, y)$

Partition

$$A \rightarrow (A_L \mid A_R), y \rightarrow \begin{pmatrix} y_T \\ y_B \end{pmatrix}$$

where A_L is $m \times 0$ and y_T is 0×1

while $m(y_T) < m(y)$ **do**

Repartition

$$(A_L \mid A_R) \rightarrow (A_0 \mid a_1 \mid A_2), \begin{pmatrix} y_T \\ y_B \end{pmatrix} \rightarrow \begin{pmatrix} y_0 \\ \frac{\psi_1}{y_2} \end{pmatrix}$$

where a_1 is a column

$$\psi_1 := a_1^T x + \psi_1$$

Continue with

$$(A_L \mid A_R) \leftarrow (A_0 \mid a_1 \mid A_2), \begin{pmatrix} y_T \\ y_B \end{pmatrix} \leftarrow \begin{pmatrix} y_0 \\ \frac{\psi_1}{y_2} \end{pmatrix}$$

endwhile

```

function [ y_out ] = Mvmult_t_unb_var1( A, x, y )

[ AL, AR ] = FLA_Part_1x2( A, ...
                          0, 'FLA_LEFT' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                      0, 'FLA_TOP' );

while ( size( AL, 2 ) < size( A, 2 ) )

    [ A0, a1, A2 ] = FLA_Repart_1x2_to_1x3( AL, AR, ...
                                           1, 'FLA_RIGHT' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                   yB, ...
                                   1, 'FLA_BOTTOM' );

    %-----%

    psi1 = laff_dots( a1, x, psi1 );

    %-----%

    [ AL, AR ] = FLA_Cont_with_1x3_to_1x2( A0, a1, A2, ...
                                           'FLA_LEFT' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file Mvmult_t_unb_var1.m.
  Click for test script test.Mvmult_t_unb_var1.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{MVMULT_T_UNB_VAR2}(A, x, y)$

Partition

$$A \rightarrow \begin{pmatrix} A_T \\ A_B \end{pmatrix}, x \rightarrow \begin{pmatrix} x_T \\ x_B \end{pmatrix}$$

where A_T is $0 \times n$ and x_T is 0×1

while $m(A_T) < m(A)$ **do**

Repartition

$$\begin{pmatrix} A_T \\ A_B \end{pmatrix} \rightarrow \begin{pmatrix} A_0 \\ \frac{a_1^T}{A_2} \end{pmatrix}, \begin{pmatrix} x_T \\ x_B \end{pmatrix} \rightarrow \begin{pmatrix} x_0 \\ \frac{\chi_1}{x_2} \end{pmatrix}$$

where a_1 is a row

$$y := \chi_1 a_1 + y$$

Continue with

$$\begin{pmatrix} A_T \\ A_B \end{pmatrix} \leftarrow \begin{pmatrix} A_0 \\ \frac{a_1^T}{A_2} \end{pmatrix}, \begin{pmatrix} x_T \\ x_B \end{pmatrix} \leftarrow \begin{pmatrix} x_0 \\ \frac{\chi_1}{x_2} \end{pmatrix}$$

endwhile

```

function [ y_out ] = Mvmult_t_unb_var2( A, x, y )

[ AT, ...
  AB ] = FLA_Part_2x1( A, ...
                      0, 'FLA.TOP' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA.TOP' );

while ( size( AT, 1 ) < size( A, 1 ) )

    [ A0, ...
      a1t, ...
      A2 ] = FLA_Repart_2x1_to_3x1( AT, ...
                                    AB, ...
                                    1, 'FLA.BOTTOM' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA.BOTTOM' );

    %-----%

    y = laff_axpy( chi1, a1t, y );

    %-----%

    [ AT, ...
      AB ] = FLA_Cont_with_3x1_to_2x1( A0, ...
                                       a1t, ...
                                       A2, ...
                                       'FLA.TOP' );



    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA.TOP' );

end

y_out = y;

return

```

 Click to view .m file Mvmult_t_unb_var2.m.
  Click for test script test_Mvmult_t_unb_var2.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{TRMVP_UN_UNB_VAR1}(U, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right)$$

where U_{TL} is 0×0 , x_T, y_T are 0×1

while $m(U_{TL}) < m(U)$ **do**

Repartition

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where v_{11}, χ_1 , and ψ_1 are scalars

$$\psi_1 := v_{11}\chi_1 + u_{12}^T x_2 + \psi_1$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Trmvp_un_unb_var1( U, x, y )

[ UTL, UTR, ...
  UBL, UBR ] = FLA_Part_2x2( U, ...
                              0, 0, 'FLA.TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA.TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                      0, 'FLA.TOP' );

while ( size( UTL, 1 ) < size( U, 1 ) )

    [ U00, u01,      U02, ...
      u10t, upsilon11, u12t, ...
      U20, u21,      U22 ] = FLA_Repart_2x2_to_3x3( UTL, UTR, ...
                                                    UBL, UBR, ...
                                                    1, 1, 'FLA.BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA.BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA.BOTTOM' );

    %-----%

    psi1 = laff_dots( upsilon11, chi1, psi1 );
    psi1 = laff_dots( u12t, x2, psi1 );

    %-----%

    [ UTL, UTR, ...
      UBL, UBR ] = FLA_Cont_with_3x3_to_2x2( U00, u01,      U02, ...
                                              u10t, upsilon11, u12t, ...
                                              U20, u21,      U22, ...
                                              'FLA.TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA.TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA.TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file Trmvp_un_unb_var1.m.
  Click for test script test.Trmvp_un_unb_var1.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{TRMVP_UN_UNB_VAR2}(U, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ y_B \end{array} \right)$$

where U_{TL} is 0×0 , x_T, y_T are 0×1

while $m(U_{TL}) < m(U)$ **do**

Repartition

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

where v_{11}, χ_1 , and ψ_1 are scalars

$$y_0 := \chi_1 u_{01} + y_0$$

$$\psi_1 := \chi_1 v_{11} + \psi_1$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Trmvp_un_unb_var2( U, x, y )

[ UTL, UTR, ...
  UBL, UBR ] = FLA_Part_2x2( U, ...
                              0, 0, 'FLA.TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA.TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                      0, 'FLA.TOP' );

while ( size( UTL, 1 ) < size( U, 1 ) )

    [ U00, u01,      U02, ...
      u10t, upsilon11, u12t, ...
      U20, u21,      U22 ] = FLA_Repart_2x2_to_3x3( UTL, UTR, ...
                                                    UBL, UBR, ...
                                                    1, 1, 'FLA.BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA.BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA.BOTTOM' );

    %-----%

    y0 = laff_axpy( chi1, u01, y0 );
    psi1 = laff_axpy( chi1, upsilon11, psi1 );

    %-----%

    [ UTL, UTR, ...
      UBL, UBR ] = FLA_Cont_with_3x3_to_2x2( U00, u01,      U02, ...
                                              u10t, upsilon11, u12t, ...
                                              U20, u21,      U22, ...
                                              'FLA.TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA.TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA.TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file Trmvp_un_unb_var2.m.
  Click for test script test.Trmvp_un_unb_var2.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{TRMVP_LN_UNB_VAR1}(L, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ y_B \end{array} \right)$$

where L_{TL} is 0×0 , x_T, y_T are 0×1

while $m(L_{TL}) < m(L)$ **do**

Repartition

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

where λ_{11}, χ_1 , and ψ_1 are scalars

$$\psi_1 := l_{10}^T x_0 + \lambda_{11} \chi_1 + \psi_1$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Trmvp_ln_unb_var1( L, x, y )

[ LTL, LTR, ...
  LBL, LBR ] = FLA_Part_2x2( L, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                      0, 'FLA_TOP' );

while ( size( LTL, 1 ) < size( L, 1 ) )

    [ L00, l01,      L02, ...
      l10t, lambda11, l12t, ...
      L20, l21,      L22 ] = FLA_Repart_2x2_to_3x3( LTL, LTR, ...
                                                    LBL, LBR, ...
                                                    1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    psi1 = laff_dots( l10t, x0, psi1 );
    psi1 = laff_dots( lambda11, chi1, psi1 );

    %-----%

    [ LTL, LTR, ...
      LBL, LBR ] = FLA_Cont_with_3x3_to_2x2( L00, l01,      L02, ...
                                              l10t, lambda11, l12t, ...
                                              L20, l21,      L22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file `Trmvp_ln_unb_var1.m`.
  Click for test script `test.Trmvp_ln_unb_var1.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{TRMVP_LN_UNB_VAR2}(L, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right)$$

where L_{TL} is 0×0 , x_T, y_T are 0×1

while $m(L_{TL}) < m(L)$ **do**

Repartition

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where λ_{11}, χ_1 , and ψ_1 are scalars

$$\psi_1 := \lambda_{11}\chi_1 + \psi_1$$

$$y_2 := \chi_1 l_{21} + y_2$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Trmvp_ln_unb_var2( L, x, y )

[ LTL, LTR, ...
  LBL, LBR ] = FLA_Part_2x2( L, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                      0, 'FLA_TOP' );

while ( size( LTL, 1 ) < size( L, 1 ) )

    [ L00, l01,      L02, ...
      l10t, lambda11, l12t, ...
      L20, l21,      L22 ] = FLA_Repart_2x2_to_3x3( LTL, LTR, ...
                                                    LBL, LBR, ...
                                                    1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    psi1 = laff_axpy( chi1, lambda11, psi1 );
    y2    = laff_axpy( chi1, l21, y2 );

    %-----%

    [ LTL, LTR, ...
      LBL, LBR ] = FLA_Cont_with_3x3_to_2x2( L00, l01,      L02, ...
                                              l10t, lambda11, l12t, ...
                                              L20, l21,      L22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file `Trmvp_ln_unb_var2.m`.
  Click for test script `test.Trmvp_ln_unb_var2.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $x := \text{TRMV_UN_UNB_VAR1}(U, x)$

Partition

$$U \rightarrow \left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right), x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right)$$

where U_{TL} is 0×0 , x_T is 0×1

while $m(U_{TL}) < m(U)$ **do**

Repartition

$$\left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c|c|c} U_{00} & u_{01} & U_{02} \\ \hline u_{10}^T & v_{11} & u_{12}^T \\ \hline U_{20} & u_{21} & U_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right)$$

where v_{11} and χ_1 are scalars

$$\chi_1 := v_{11}\chi_1$$

$$\chi_1 := u_{12}^T x_2 + \chi_1$$

Continue with

$$\left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c|c|c} U_{00} & u_{01} & U_{02} \\ \hline u_{10}^T & v_{11} & u_{12}^T \\ \hline U_{20} & u_{21} & A_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right)$$

endwhile

```

function [ x_out ] = Trmv_un_unb_var1( U, x )

[ UTL, UTR, ...
  UBL, UBR ] = FLA_Part_2x2( U, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA_TOP' );

while ( size( UTL, 1 ) < size( U, 1 ) )

    [ U00, u01,      U02, ...
      u10t, upsilon11, u12t, ...
      U20, u21,      U22 ] = FLA_Repart_2x2_to_3x3( UTL, UTR, ...
                                                    UBL, UBR, ...
                                                    1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    chi1 = laff_dot( upsilon11, chi1 );
    chi1 = laff_dots( u12t, x2, chi1 );

    %-----%

    [ UTL, UTR, ...
      UBL, UBR ] = FLA_Cont_with_3x3_to_2x2( U00, u01,      U02, ...
                                              u10t, upsilon11, u12t, ...
                                              U20, u21,      U22, ...
                                              'FLA_TL' );



    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );

end

x_out = [ xT
          xB ];

return

```

 Click to view .m file Trmv_un_unb_var1.m.
  Click for test script test.Trmv_un_unb_var1.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $x := \text{TRMV_UN_UNB_VAR2}(U, x)$

Partition

$$U \rightarrow \left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right), x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right)$$

where U_{TL} is 0×0 , x_T is 0×1

while $m(U_{TL}) < m(U)$ **do**

Repartition

$$\left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c|c|c} U_{00} & u_{01} & U_{02} \\ \hline u_{10}^T & v_{11} & u_{12}^T \\ \hline U_{20} & u_{21} & U_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right)$$

where v_{11} and χ_1 are scalars

$$x_0 := \chi_1 u_{01} + x_0$$

$$\chi_1 := \chi_1 v_{11}$$

Continue with

$$\left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline U_{BL} & U_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c|c|c} U_{00} & u_{01} & U_{02} \\ \hline u_{10}^T & v_{11} & u_{12}^T \\ \hline U_{20} & u_{21} & A_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right)$$

endwhile

```

function [ x_out ] = Trmv_un_unb_var2( U, x )

[ UTL, UTR, ...
  UBL, UBR ] = FLA_Part_2x2( U, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA_TOP' );

while ( size( UTL, 1 ) < size( U, 1 ) )

    [ U00, u01,      U02, ...
      u10t, upsilon11, u12t, ...
      U20, u21,      U22 ] = FLA_Repart_2x2_to_3x3( UTL, UTR, ...
                                                    UBL, UBR, ...
                                                    1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    x0 = laff_axpy( chi1, u01, x0 );
    chi1 = laff_dot( upsilon11, chi1 );

    %-----%

    [ UTL, UTR, ...
      UBL, UBR ] = FLA_Cont_with_3x3_to_2x2( U00, u01,      U02, ...
                                              u10t, upsilon11, u12t, ...
                                              U20, u21,      U22, ...
                                              'FLA_TL' );



    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );

end

x_out = [ xT
          xB ];

return

```

 Click to view .m file Trmv_un_unb_var2.m.
  Click for test script test.Trmv_un_unb_var2.m. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $[x] := \text{TRMV_LN_UNB_VAR1}(L, x)$

Partition

$$L \rightarrow \left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right), x \rightarrow \left(\begin{array}{c} x_T \\ x_B \end{array} \right)$$

where L_{BR} is 0×0 , x_B has 0 rows

while $m(L_{BR}) < m(L)$ **do**

Repartition

$$\left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c|c|c} L_{00} & l_{01} & L_{02} \\ \hline l_{10}^T & \lambda_{11} & l_{12}^T \\ \hline L_{20} & l_{21} & L_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right)$$

where λ_{11} is 1×1 , χ_1 has 1 row

$$\chi_1 := \lambda_{11} \chi_1$$

$$\chi_1 := l_{10}^T x_0 + \chi_1$$

Continue with

$$\left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c|c|c} L_{00} & l_{01} & L_{02} \\ \hline l_{10}^T & \lambda_{11} & l_{12}^T \\ \hline L_{20} & l_{21} & L_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right)$$

endwhile

```

function [ x_out ] = Trmv_ln_unb_var1( L, x )

[ LTL, LTR, ...
  LBL, LBR ] = FLA_Part_2x2( L, ...
                             0, 0, 'FLA_BR' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLABOTTOM' );

while ( size( LBR, 1 ) < size( L, 1 ) )

    [ L00,  l01,      L02,  ...
      l10t, lambda11, l12t, ...
      L20,  l21,      L22 ] = FLA_Repart_2x2_to_3x3( LTL, LTR, ...
                                                    LBL, LBR, ...
                                                    1, 1, 'FLA_TL' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_TOP' );

    %-----%

    chi1 = laff_dot( lambda11, chi1 );
    chi1 = laff_dot( l10t, x0, chi1 );

    %-----%

    [ LTL, LTR, ...
      LBL, LBR ] = FLA_Cont_with_3x3_to_2x2( L00,  l01,      L02,  ...
                                              l10t, lambda11, l12t, ...
                                              L20,  l21,      L22, ...
                                              'FLA_BR' );



    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLABOTTOM' );

end

x_out = [ xT
          xB ];

return

```

 Click to view .m file `Trmv_ln_unb_var1.m`.
  Click for test script `test.Trmv_ln_unb_var1.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $[x] := \text{TRMV_LN_UNB_VAR2}(L, x)$

Partition

$$L \rightarrow \left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right), x \rightarrow \left(\begin{array}{c} x_T \\ x_B \end{array} \right)$$

where L_{BR} is 0×0 , x_B has 0 rows

while $m(L_{BR}) < m(L)$ **do**

Repartition

$$\left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c|c|c} L_{00} & l_{01} & L_{02} \\ \hline l_{10}^T & \lambda_{11} & l_{12}^T \\ \hline L_{20} & l_{21} & L_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right)$$

where λ_{11} is 1×1 , χ_1 has 1 row

$$x_2 := \chi_1 l_{21} + x_2$$

$$\chi_1 := \chi_1 \lambda_{11}$$

Continue with

$$\left(\begin{array}{c|c} L_{TL} & L_{TR} \\ \hline L_{BL} & L_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c|c|c} L_{00} & l_{01} & L_{02} \\ \hline l_{10}^T & \lambda_{11} & l_{12}^T \\ \hline L_{20} & l_{21} & L_{22} \end{array} \right), \left(\begin{array}{c} x_T \\ x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right)$$

endwhile

```

function [ x_out ] = Trmv_ln_unb_var2( L, x )

[ LTL, LTR, ...
  LBL, LBR ] = FLA_Part_2x2( L, ...
                              0, 0, 'FLA_BR' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                       0, 'FLABOTTOM' );

while ( size( LBR, 1 ) < size( L, 1 ) )

    [ L00,  l01,      L02,  ...
      l10t, lambda11, l12t, ...
      L20,  l21,      L22 ] = FLA_Repart_2x2_to_3x3( LTL, LTR, ...
                                                       LBL, LBR, ...
                                                       1, 1, 'FLA_TL' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                     xB, ...
                                     1, 'FLA_TOP' );

    %-----%

    x2 = laff_axpy( chi1, l21, x2 );
    chi1 = laff_dot( chi1, lambda11 );

    %-----%

    [ LTL, LTR, ...
      LBL, LBR ] = FLA_Cont_with_3x3_to_2x2( L00,  l01,      L02,  ...
                                              l10t, lambda11, l12t, ...
                                              L20,  l21,      L22, ...
                                              'FLA_BR' );



    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLABOTTOM' );

end

x_out = [ xT
          xB ];

return

```

 Click to view .m file `Trmv_ln_unb_var2.m`.
  Click for test script `test.Trmv_ln_unb_var2.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{SYMV_U_UNB_VAR1}(A, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ y_B \end{array} \right)$$

where A_{TL} is 0×0 , x_T, y_T are 0×1

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

Repartition

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

where α_{11}, χ_1 , and ψ_1 are scalars

$$\psi_1 := a_{01}^T x_0 + \alpha_{11} \chi_1 + a_{12}^T x_2 + \psi_1$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Symv_u_unb_var1( A, x, y )

[ ATL, ATR, ...
  ABL, ABR ] = FLA_Part_2x2( A, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                      0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                      0, 'FLA_TOP' );

while ( size( ATL, 1 ) < size( A, 1 ) )

    [ A00, a01, A02, ...
      a10t, alpha11, a12t, ...
      A20, a21, A22 ] = FLA_Repart_2x2_to_3x3( ATL, ATR, ...
                                                ABL, ABR, ...
                                                1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    psi1 = laff_dots( a01, x0, psi1 );
    psi1 = laff_dots( alpha11, chi1, psi1 );
    psi1 = laff_dots( a12t, x2, psi1 );

    %-----%

    [ ATL, ATR, ...
      ABL, ABR ] = FLA_Cont_with_3x3_to_2x2( A00, a01, A02, ...
                                              a10t, alpha11, a12t, ...
                                              A20, a21, A22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file `Symv_u_unb_var1.m`.
  Click for test script `test_Symv_u_unb_var1.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{SYMV_U_UNB_VAR2}(A, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right)$$

where A_{TL} is 0×0 , x_T, y_T are 0×1

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

Repartition

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where α_{11}, χ_1 , and ψ_1 are scalars

$$y_0 := \chi_1 a_{01} + y_0$$

$$\psi_1 := \alpha_{11} \chi_1 + \psi_1$$

$$y_2 := \chi_1 (a_{12}^T)^T + y_2$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Symv_u_unb_var2( A, x, y )

[ ATL, ATR, ...
  ABL, ABR ] = FLA_Part_2x2( A, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                       0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                       0, 'FLA_TOP' );

while ( size( ATL, 1 ) < size( A, 1 ) )

    [ A00, a01, A02, ...
      a10t, alpha11, a12t, ...
      A20, a21, A22 ] = FLA_Repart_2x2_to_3x3( ATL, ATR, ...
                                                ABL, ABR, ...
                                                1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    y0 = laff_axpy( chi1, a01, y0 );
    psi1 = laff_axpy( chi1, alpha11, psi1 );
    y2 = laff_axpy( chi1, a12t, y2 );

    %-----%

    [ ATL, ATR, ...
      ABL, ABR ] = FLA_Cont_with_3x3_to_2x2( A00, a01, A02, ...
                                              a10t, alpha11, a12t, ...
                                              A20, a21, A22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file `Symv_u_unb_var2.m`.
  Click for test script `test_Symv_u_unb_var2.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{SYMV_L_UNB_VAR1}(A, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ y_B \end{array} \right)$$

where A_{TL} is 0×0 , x_T, y_T are 0×1

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

Repartition

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

where α_{11}, χ_1 , and ψ_1 are scalars

$$\psi_1 := a_{10}^T x_0 + \alpha_{11} \chi_1 + a_{21}^T x_2 + \psi_1$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \chi_1 \\ x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \psi_1 \\ y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Symv_l_unb_var1( A, x, y )

[ ATL, ATR, ...
  ABL, ABR ] = FLA_Part_2x2( A, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                       0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                       0, 'FLA_TOP' );

while ( size( ATL, 1 ) < size( A, 1 ) )

    [ A00, a01, A02, ...
      a10t, alpha11, a12t, ...
      A20, a21, A22 ] = FLA_Repart_2x2_to_3x3( ATL, ATR, ...
                                                ABL, ABR, ...
                                                1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    psi1 = laff_dots( a10t, x0, psi1 );
    psi1 = laff_dots( alpha11, chi1, psi1 );
    psi1 = laff_dots( a21, x2, psi1 );

    %-----%

    [ ATL, ATR, ...
      ABL, ABR ] = FLA_Cont_with_3x3_to_2x2( A00, a01, A02, ...
                                              a10t, alpha11, a12t, ...
                                              A20, a21, A22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file `Symv_l_unb_var1.m`.
  Click for test script `test_Symv_l_unb_var1.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{SYMV_L_UNB_VAR2}(A, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right)$$

where A_{TL} is 0×0 , x_T, y_T are 0×1

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

Repartition

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where α_{11}, χ_1 , and ψ_1 are scalars

$$y_0 := \chi_1 (a_{10}^T)^T + y_0$$

$$\psi_1 := \alpha_{11} \chi_1 + \psi_1$$

$$y_2 := \chi_1 a_{21} + y_2$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Symv_l_unb_var2( A, x, y )

[ ATL, ATR, ...
  ABL, ABR ] = FLA_Part_2x2( A, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                       0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                       0, 'FLA_TOP' );

while ( size( ATL, 1 ) < size( A, 1 ) )

    [ A00, a01, A02, ...
      a10t, alpha11, a12t, ...
      A20, a21, A22 ] = FLA_Repart_2x2_to_3x3( ATL, ATR, ...
                                                ABL, ABR, ...
                                                1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    y0 = laff_axpy( chi1, a10t, y0 );
    psi1 = laff_axpy( chi1, alpha11, psi1 );
    y2 = laff_axpy( chi1, a21, y2 );

    %-----%

    [ ATL, ATR, ...
      ABL, ABR ] = FLA_Cont_with_3x3_to_2x2( A00, a01, A02, ...
                                              a10t, alpha11, a12t, ...
                                              A20, a21, A22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file `Symv_l_unb_var2.m`.
  Click for test script `test_Symv_l_unb_var2.m`. Then copy and paste it into PictureFlame to watch it in action.

Algorithm: $y := \text{SYMV_U_UNB_VAR3}(A, x, y)$

Partition

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

$$x \rightarrow \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right), y \rightarrow \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right)$$

where A_{TL} is 0×0 , x_T , y_T are 0×1

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

Repartition

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where α_{11} , χ_1 , and ψ_1 are scalars

$$y_0 := \chi_1 a_{01} + y_0$$

$$\psi_1 := \alpha_{11} \chi_1 + \psi_1$$

$$\psi_1 := a_{01}^T x_0 + \psi_1$$

Continue with

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

$$\left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

```

function [ y_out ] = Symv_u_unb_var3( A, x, y )

[ ATL, ATR, ...
  ABL, ABR ] = FLA_Part_2x2( A, ...
                             0, 0, 'FLA_TL' );

[ xT, ...
  xB ] = FLA_Part_2x1( x, ...
                       0, 'FLA_TOP' );

[ yT, ...
  yB ] = FLA_Part_2x1( y, ...
                       0, 'FLA_TOP' );

while ( size( ATL, 1 ) < size( A, 1 ) )

    [ A00, a01, A02, ...
      a10t, alpha11, a12t, ...
      A20, a21, A22 ] = FLA_Repart_2x2_to_3x3( ATL, ATR, ...
                                                ABL, ABR, ...
                                                1, 1, 'FLA_BR' );

    [ x0, ...
      chi1, ...
      x2 ] = FLA_Repart_2x1_to_3x1( xT, ...
                                    xB, ...
                                    1, 'FLA_BOTTOM' );

    [ y0, ...
      psi1, ...
      y2 ] = FLA_Repart_2x1_to_3x1( yT, ...
                                    yB, ...
                                    1, 'FLA_BOTTOM' );

    %-----%

    y0 = laff_axpy( chi1, a01, y0 );
    psi1 = laff_axpy( chi1, alpha11, psi1 );
    psi1 = laff_dots( a01, x0, psi1 );

    %-----%

    [ ATL, ATR, ...
      ABL, ABR ] = FLA_Cont_with_3x3_to_2x2( A00, a01, A02, ...
                                              a10t, alpha11, a12t, ...
                                              A20, a21, A22, ...
                                              'FLA_TL' );

    [ xT, ...
      xB ] = FLA_Cont_with_3x1_to_2x1( x0, ...
                                       chi1, ...
                                       x2, ...
                                       'FLA_TOP' );



    [ yT, ...
      yB ] = FLA_Cont_with_3x1_to_2x1( y0, ...
                                       psi1, ...
                                       y2, ...
                                       'FLA_TOP' );

end

y_out = [ yT
          yB ];

return

```

 Click to view .m file `Symv_u_unb_var3.m`.
  Click for test script `test_Symv_u_unb_var3.m`. Then copy and paste it into PictureFlame to watch it in action.