E1.3.5 Exam Question 5

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Exam 1 due Oct 31, 2023 09:12 IST

Question 5

2/2 points (graded)

```
function [ y_out ] = matvec( A, x, y )

n = size( A, 1 );
for j = 1:n

    for i = 1:j-1
        y( i ) = A( i,j ) * x( j ) + y( i );
    end

    y( j ) = A( j,j ) * x( j ) + y( j );

    for i = j+1:n
        y( i ) = A( i,j ) * x( j ) + y( i );
    end

end

y_out = y;

return
```

$[y] := \textsc{Matvec\_unb\_var2}(A, x, y)$

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 has 0 rows, y_T has 0 rows

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

Repartition

$$\left(\begin{array}{c|c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \rightarrow \left(\begin{array}{c|c|c} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ \hline A_{20} & a_{21} & A_{22} \end{array} \right), \quad \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \rightarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \quad \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \rightarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

where α_{11} is 1×1, χ_1 has 1 row, ψ_1 has 1 row

$$y_0 := \chi_1 a_{01} + y_0$$
$$\psi_1 := \chi_1 \alpha_{11} + \psi_1$$
$$y_2 := \chi_1 a_{21} + y_2$$

Continue with

$$\left(\begin{array}{c|c} A_{TL} & A_{TR} \\ \hline A_{BL} & A_{BR} \end{array} \right) \leftarrow \left(\begin{array}{c|c|c} A_{00} & a_{01} & A_{02} \\ \hline a_{10}^T & \alpha_{11} & a_{12}^T \\ \hline A_{20} & a_{21} & A_{22} \end{array} \right), \quad \left(\begin{array}{c} x_T \\ \hline x_B \end{array} \right) \leftarrow \left(\begin{array}{c} x_0 \\ \hline \chi_1 \\ \hline x_2 \end{array} \right), \quad \left(\begin{array}{c} y_T \\ \hline y_B \end{array} \right) \leftarrow \left(\begin{array}{c} y_0 \\ \hline \psi_1 \\ \hline y_2 \end{array} \right)$$

endwhile

Both the MATLAB code on the left and the algorithm (expressed with FLAME notation) to its right implement the computation $y := Ax + y$ (matrix-vector multiplication).

"Mark" on the above code/algorithm what you would modify so that the code/algorithm computes $y := Ax + y$ where A is symmetric, stored only in the lower triangular part of array A (or matrix A). Then answer the following questions:

Which of the following modifications to the MATLAB code on the left yield implementations that compute $y := Ax + y$ where A is symmetric, stored only in the lower triangular part of array A (mark all correct modifications):

☑ Change

```
for i = 1:j-1
   y( i ) = A( i,j ) * x( j ) + y( i );
end
```

to

```
for i = 1:j-1
```

```
for i = 1:j-1
   y( i ) = A( j,i ) * x( j ) + y( i );
end
```

- [ ] Change

```
for i = j+1:n
   y( i ) = A( i,j ) * x( j ) + y( i );
end
```

to

```
for i = j+1:n
   y( i ) = A( j,i ) * x( j ) + y( i );
end
```

- [ ] Delete

```
for i = 1:j-1
   y( i ) = A( i,j ) * x( j ) + y( i );
end
```

- [ ] Delete

```
for i = j+1:n
   y( i ) = A( i,j ) * x( j ) + y( i );
end
```

✔

```
function [ y_out ] = matvec( A, x, y )

n = size( A, 1 );
for j = 1:n

  for i = 1:j-1
    y( i ) = A( j,i ) * x( j ) + y( i );
  end

  y( j ) = A( j,j ) * x( j ) + y( j );

  for i = j+1:n
    y( i ) = A( i,j ) * x( j ) + y( i );
  end

end

y_out = y;

return
```

Which of the following modifications to the algorithm on the right yield implementations that compute $y := Ax$ + y where A is symmetric, stored only in the lower triangular part of matrix A:

Calculator

- [ ] Change $y_2 = \chi_1 a_{21} + y_2$ to $y_2 = \chi_1 (a_{12}^T)^T + y_2$
- [x] Change $y_0 = \chi_1 a_{01} + y_0$ to $y_0 = \chi_1 (a_{10}^T)^T + y_0$
- [ ] Delete $y_2 = \chi_1 a_{21} + y_2$
- [ ] Delete $y_0 = \chi_1 a_{01} + y_0$

✔

$[y] := \text{MATVEC\_UNB\_VAR2}(A, x, y)$

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

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