6.3.3 Solving Ux = b (Back substitution)

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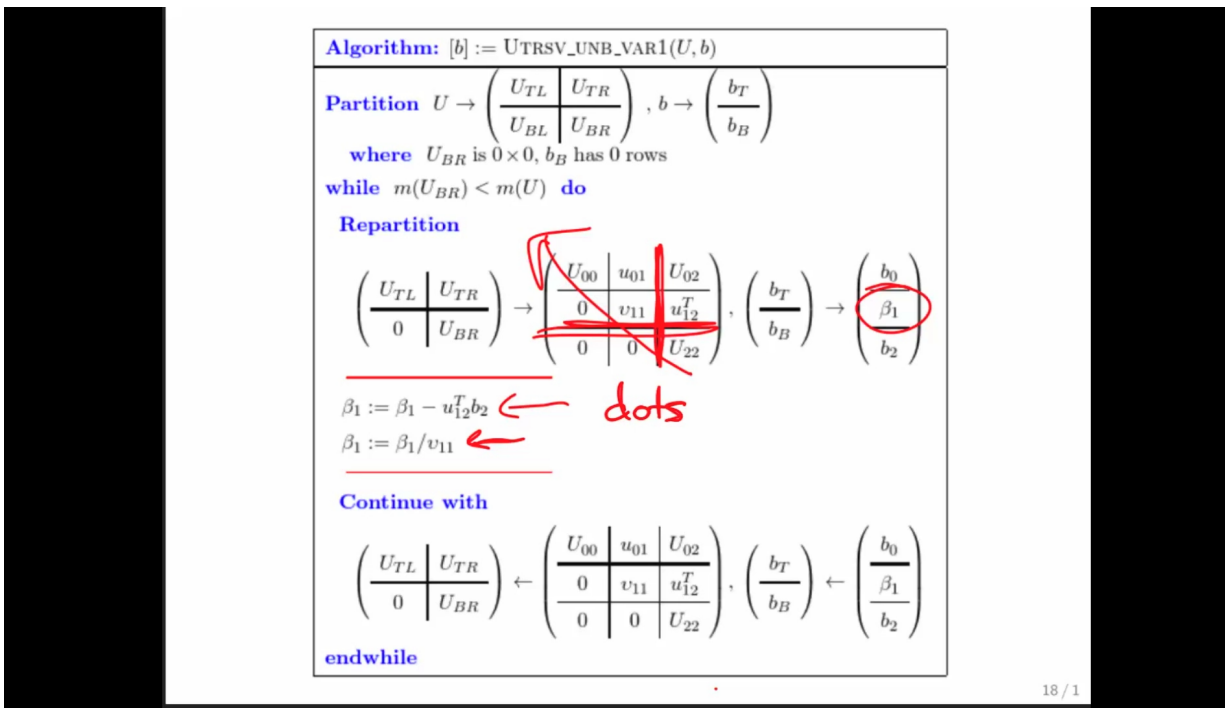
Week 6 due Nov 13, 2023 12:12 IST

6.3.3 Solving Ux = b (Back substitution)



the last element of the top part of b.

What do we do there?

We update it as such.

And what you notice is that that's a dot product.

As a matter of fact, we have this laff.dots routine

that would be just perfect for that computation.

And then we have to divide beta 1 by epsilon 11, which

is the current coefficient in U that's exposed.

Now we have an algorithm for solving Ux equals b, which is the same as back substitution.

4:51 / 5:06 2.0x

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Reading Assignment

0 points possible (ungraded)

Read Unit 6.3.3 of the notes. [LINK]

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? Question 5

? assign X2 to b2

How can we assign b2=x2 when b2=U22*b2? Wouldn't U22 have to be an identity matrix for that to hold?

Calculator

? Error in HW code

When I run my Matlab code for Utrsv_unb_var1, I get the following error: Error using FLA_Cont_with_3x1_to_2x1 input matrices must have the sa...

5

Homework 6.3.3.1

3/3 points (graded)

Algorithm: $[b] := \text{UTRSV\_UNB\_VAR1}(U, b)$

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

where U_{BR} is 0×0, b_B has 0 rows

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

Repartition

$$\left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline 0 & U_{BR} \end{array}\right) \rightarrow \left(\begin{array}{c|c|c} U_{00} & u_{01} & U_{02} \\ \hline 0 & \upsilon_{11} & u_{12}^T \\ \hline 0 & 0 & U_{22} \end{array}\right), \left(\begin{array}{c} b_T \\ \hline b_B \end{array}\right) \rightarrow \left(\begin{array}{c} b_0 \\ \hline \beta_1 \\ \hline b_2 \end{array}\right)$$

$\beta_1 := \beta_1 - u_{12}^T b_2$

$\beta_1 := \beta_1 / \upsilon_{11}$

Continue with

$$\left(\begin{array}{c|c} U_{TL} & U_{TR} \\ \hline 0 & U_{BR} \end{array}\right) \leftarrow \left(\begin{array}{c|c|c} U_{00} & u_{01} & U_{02} \\ \hline 0 & \upsilon_{11} & u_{12}^T \\ \hline 0 & 0 & U_{22} \end{array}\right), \left(\begin{array}{c} b_T \\ \hline b_B \end{array}\right) \leftarrow \left(\begin{array}{c} b_0 \\ \hline \beta_1 \\ \hline b_2 \end{array}\right)$$

endwhile

With pencil and paper, side-by-side, solve the upper triangular linear system

$$\begin{aligned} -2\chi_0 - \chi_1 + \chi_2 &= 6 \\ -3\chi_1 - 2\chi_2 &= 9 \\ \chi_2 &= 3 \end{aligned}$$

via back substitution and by executing the above algorithm with inputs

$$U = \begin{pmatrix} -2 & -1 & 1 \\ 0 & -3 & -2 \\ 0 & 0 & 1 \end{pmatrix} \text{ and } b = \begin{pmatrix} 6 \\ 9 \\ 3 \end{pmatrix}.$$

$\chi_0 =$ 1 ✔ Answer: 1

$\chi_1 =$ -5 ✔ Answer: -5

$\chi_2 =$ 3 ✔ Answer: 3

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Answers are displayed within the problem

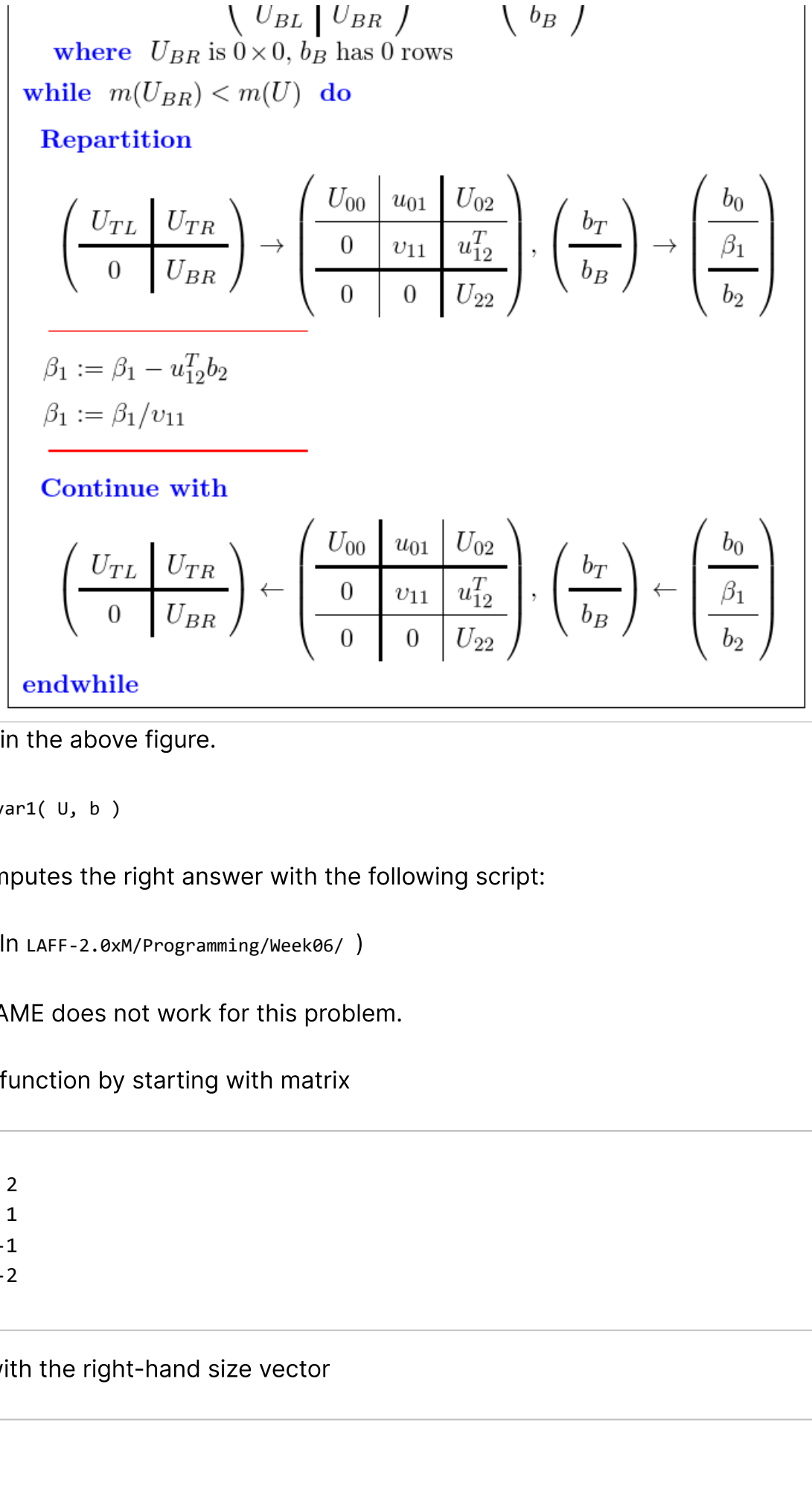
Homework 6.3.3.2

1/1 point (graded)

Algorithm: $[b] := \text{UTRSV\_UNB\_VAR1}(U, b)$

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

Calculator



Implement the algorithm in the above figure.

- `[ b_out ] = Utrsv_unb_var1( U, b )`

You can check that it computes the right answer with the following script:

- `test_Utrsv_unb_var1.m` (In `LAFF-2.0xM/Programming/Week06/`)

Unfortunately, PictureFLAME does not work for this problem.

This script exercises the function by starting with matrix

```
U = [
     2     0     1     2
     0    -1     2     1
     0     0     1    -1
     0     0     0    -2
]
```

Next, it solves $Ux = b$ with the right-hand size vector

```
b = [
     2
     4
     3
     2
]
```

by calling

```
x = Utrsv_unb_var1( U, b )
```

Finally, it checks if `x` indeed solves $Ux = b$ by computing

```
b - U * x
```

which should yield a zero vector of size four.

☑ Done/Skip

✔

Here is our implementations of the function:

- `Utrsv_unb_var1.m`

Calculator

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Answers are displayed within the problem

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Calculator