7.2.2 The Problem

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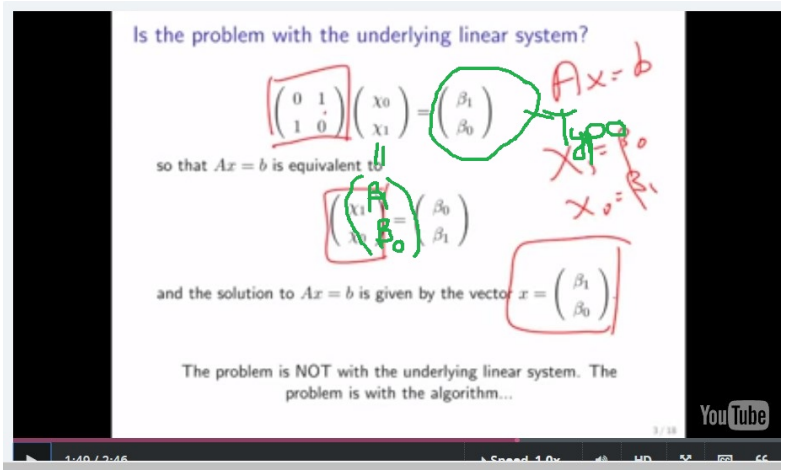
There is a typo in the following video. In particular, in the slide



The error is circled in green in the above. The elements beta_0 and beta_1 of vector b should be reversed.

Thank you to Neon-007 for reporting.

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Homework 7.2.2.1

1/1 point (graded)

Solve the following linear system, via the steps in Gaussian elimination that you have learned so far.

$$\begin{array}{rrrr} 2\chi_0+ & 4\chi_1+ & (-2)\chi_2 = & -10 \\ 4\chi_0+ & 8\chi_1+ & 6\chi_2 = & 20 \\ 6\chi_0+ & (-4)\chi_1+ & 2\chi_2 = & 18 \end{array}$$

Mark all that are correct:

- [x] The process breaks down. ✔
- [ ] There is no solution
- [x] $\begin{pmatrix} \chi_0 \\ \chi_1 \\ \chi_2 \end{pmatrix} = \begin{pmatrix} 1 \\ -1 \\ 4 \end{pmatrix}$ ✔

Explanation

Answer: (a) and (c)

Solving this linear system via Gaussian elimination relies on the fact that its solution does not change if equations are reordered.

Now,

- By subtracting $(4/2) = 2$ times the first row from the second row and $(6/2) = 3$ times the first row from the third row, we get

$$\begin{aligned} 2\chi_0 + \quad & 4\chi_1 + (-2)\chi_2 = -10 \\ 0\chi_0 + \quad & 0\chi_1 + \quad 10\chi_2 = \quad 40 \\ 0\chi_0 + (-16)\chi_1 + \quad & 8\chi_2 = \quad 48 \end{aligned}$$

- Now we've got a problem. The algorithm we discussed so far would want to subtract $((-16)/0)$ times the second row from the third row, which causes a divide-by-zero error. Instead, we have to use the fact that reordering the equations does not change the answer, swapping the second row with the third:

$$\begin{aligned} 2\chi_0 + \quad & 4\chi_1 + (-2)\chi_2 = -10 \\ 0\chi_0 + (-16)\chi_1 + \quad & 8\chi_2 = \quad 48 \\ 0\chi_0 + \quad & 0\chi_1 + \quad 10\chi_2 = \quad 40 \end{aligned}$$

  at which point we are done transforming our system into an upper triangular system, and the backward substition can commence to solve the problem.

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Answers are displayed within the problem

Video

Perform Gaussian elimination on

$$\begin{aligned} 0x_0+ \quad & 4x_1+ \quad (-2)x_2 = \quad -10 \\ 4x_0+ \quad & 8x_1+ \quad 6x_2 = \quad 20 \\ 6x_0+ \quad & (-4)x_1+ \quad 2x_2 = \quad 18 \end{aligned}$$

Mark all that are correct:

- [x] The process breaks down. ✔
- [ ] There is no solution
- [x] After reducing the system to an upper triangular system, the right-hand side equals $\begin{matrix} 20 \\ -10 \\ -52 \end{matrix}$ ✔

✔

Explanation

Answer:

- We start by trying to subtract $(4/0)$ times the first row from the second row and $(6/0)$ times the first row from the third row. This causes a "divide by zero" error.
- Instead, we begin by swaping the first row with any of the other two rows:

$$\begin{aligned} 4\chi_0 + \quad & 8\chi_1 + \quad 6\chi_2 = \ 20 \\ 0\chi_0 + \quad & 4\chi_1 + (-2)\chi_2 = -10 \\ 6\chi_0 + (-4)\chi_1 + \quad & 2\chi_2 = \ 18 \end{aligned}$$

- By subtracting $(0/4) = 0$ times the first row from the second row and $(6/4) = 3/2$ times the first row from the third row, we get

$$\begin{aligned} 4\chi_0 + \quad & 8\chi_1 + \quad 6\chi_2 = \ 20 \\ 0\chi_0 + \quad & 4\chi_1 + (-2)\chi_2 = -10 \\ 0\chi_0 + (-16)\chi_1 + (-7)\chi_2 = & -12 \end{aligned}$$

- Next, we subtract $(-16)/4 = -4$ times the second row from the third to obtain

$$\begin{aligned} 4\chi_0 + 8\chi_1 + \quad & 6\chi_2 = \ 20 \\ 0\chi_0 + 4\chi_1 + \ (-2)\chi_2 = & -10 \\ 0\chi_0 + 0\chi_1 + (-15)\chi_2 = & -52 \end{aligned}$$

at which point we are done transforming our system into an upper triangular system, and the backward substition can commence to solve the problem.

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Answers are displayed within the problem