1. More Determinants

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Practice

Using the 2×2 determinant

3/3 points (graded)

Let's use the determinant to answer a question about linear systems.

Consider the system:

$$\begin{aligned} -4x + cy &= 4 \\ cx - \ y &= 1 \end{aligned}$$

1. Suppose $c = 1$. Which of the following applies?

- there is no solution
- there is a unique solution
- there are multiple solutions

✔

2. Find the largest possible value of c such that the corresponding matrix is not invertible.

$c =$ 2 ✔

3. For that value of c, which of the following applies?

- there is no solution
- there is a unique solution
- there are multiple solutions

✔

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Determinant for 3×3

In lecture, we saw how to compute the determinant of a 2×2 matrix. In this section, we will compute the determinant of a 3×3 matrix. Recall that **the determinant is important because it has to be nonzero in order for the matrix to be invertible.** Computing the full inverse of a 3×3 matrix is a little complicated, so we will just focus on the determinant for now.

We use absolute value bars for the determinant of a matrix:

$$|A| = \det(M). \tag{5.85}$$

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For example,

For example,

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc. \tag{5.86}$$

What should be the determinant of a 3×3 matrix?

$$\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = ? \tag{5.87}$$

Determinant in 3×3

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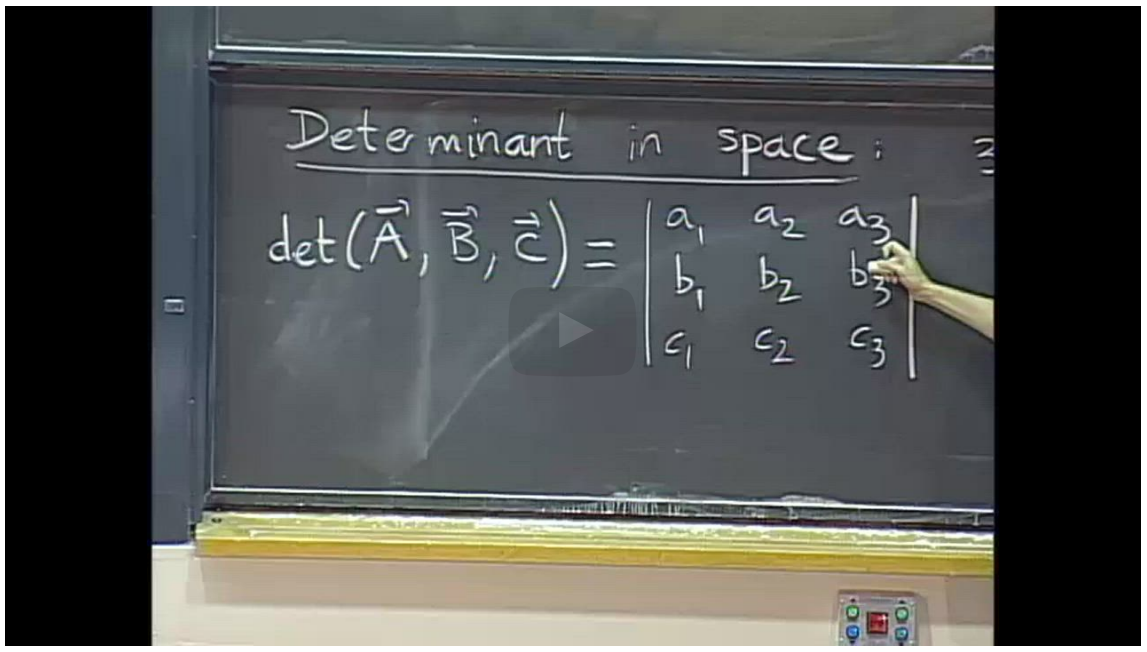

0:00 / 0:00 2.0x

PROFESSOR: And of course I have to give a meaning to this,

so this will be a number.

And what is that number?

Well, the definition I will take is

that this is a1 times the determinant

of what I get by looking in this lower right corner.

So the 2 by 2 determinant--

b2, b3, c2, c3.

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To find the determinant of a 3×3 matrix, we have the following formula.

$$\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = a_1 \begin{vmatrix} b_2 & b_3 \\ c_2 & c_3 \end{vmatrix} - a_2 \begin{vmatrix} b_1 & b_3 \\ c_1 & c_3 \end{vmatrix} + a_3 \begin{vmatrix} b_1 & b_2 \\ c_1 & c_2 \end{vmatrix}. \tag{5.88}$$

Determinant Formula Structure

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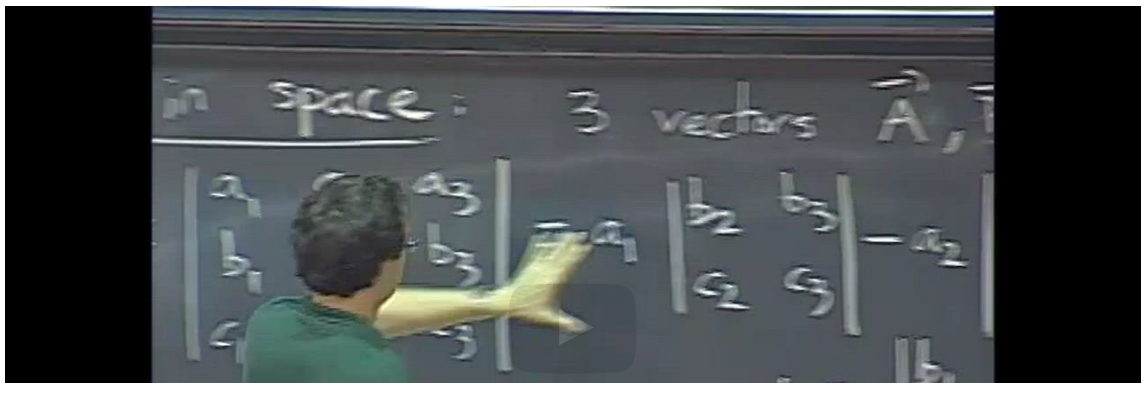

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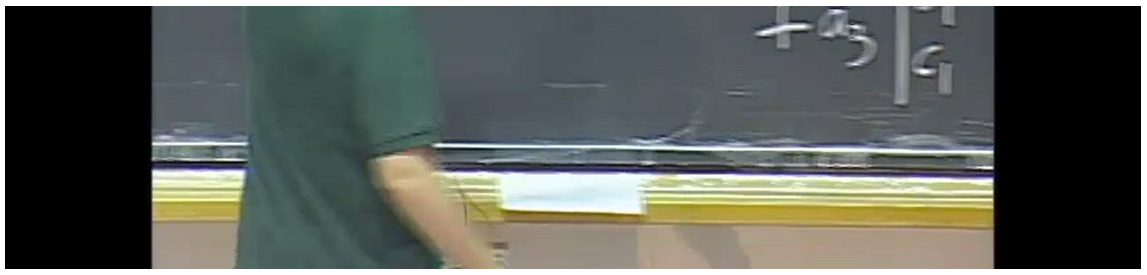

0:00 / 0:00 2.0x

PROFESSOR: So, how to remember the structure of this formula.

Well, it's called-- this is called an expansion according

to the first row.

So we're going to take the entries in the first row-- a 1,

a 2, a 3--

and for each of them we get a term.

Namely, we multiply it by a 2 by 2

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How to Remember

The formula is easier to remember if you can see where each term comes from. In the first term, $a_1 \begin{vmatrix} b_2 & b_3 \\ c_2 & c_3 \end{vmatrix}$, we see the determinant of the submatrix obtained by deleting the row and column containing a_1. The same pattern is true for the terms with a_2 and a_3, except for the (easily forgotten!) minus sign in front of a_2. By remembering this pattern, you can remember the entire formula.

Determinant Practice

1/1 point (graded)
Compute the following determinant.

$$\begin{vmatrix} 2 & 3 & 3 \\ 2 & 4 & 5 \\ 1 & 1 & 2 \end{vmatrix} =$$ 3

✔ **Answer:** 3

Solution:

$$\begin{vmatrix} 2 & 3 & 3 \\ 2 & 4 & 5 \\ 1 & 1 & 2 \end{vmatrix} = 2\begin{vmatrix} 4 & 5 \\ 1 & 2 \end{vmatrix} - 3\begin{vmatrix} 2 & 5 \\ 1 & 2 \end{vmatrix} + 3\begin{vmatrix} 2 & 4 \\ 1 & 1 \end{vmatrix} = 3 \tag{5.89}$$

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Answers are displayed within the problem

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[Staff] formula error (5.88) 3
I know it's covered in the video right below, but it looks like the third piece of the formula in 5.88 is incorrect. Just a heads up to any...

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