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## Exercises: Uniqueness of solutions

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### Underdetermined matrices

1/1 point (ungraded)

Let the system of equations be given by  $y = A_i x$ , with  $i = 1, 2, 3, 4$ . Which of the following  $A_i$  results in a underdetermined system?

☐  $A_1 = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$

☒  $A_2 = \begin{bmatrix} 3 & 6 \\ 1 & 2 \\ 1 & 2 \end{bmatrix}$

☒  $A_3 = \begin{bmatrix} 3 & 1 & 2 \\ 1 & 0 & \frac{2}{3} \\ 6 & 1 & 4 \end{bmatrix}$

- ▶ 4. Best Linear Unbiased Estimation (BLUE)
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☐

$$A_4 = \begin{bmatrix} 3 & 1 & 2 \\ 1 & 0 & 2 \\ 6 & 1 & 4 \end{bmatrix}$$



### Explanation

The rank of  $A_2$  is 1, whereas  $n = 2$ ; the second column is simply 2 times the first column. The rank of  $A_3$  is 2, whereas  $n = 3$ ; the third column is 2/3 times the first column. In these cases, the columns are not independent.

You may also compute the rank of a matrix with Matlab, using e.g. `rank(A2)` with A2 the matrix of interest.

✓ Correct (1/1 point)

### Is there a solution?

5/5 points (ungraded)

Assume we have a system of equations  $y = Ax$ .

For each  $A$ -matrix, select one of the options:

$$A = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$$

☒ system will have one solution ✓

☐ system may have a solution

☐ system does not have a solution

### Answer

Correct:  $\text{rank}(A) = 2 = m = n$

$$A = \begin{bmatrix} 3 & 6 \\ 1 & 2 \\ 1 & 2 \end{bmatrix}$$

☐ system will have one solution

☒ system may have a solution ✓

☐ system does not have a solution

### Answer

Correct:  $\text{rank}(A) = 1$ , and  $m = 3$ . The rank is smaller than  $m$  so there might be a solution.

$$A = \begin{bmatrix} 1 & 6 \\ 1 & 2 \\ 1 & 3 \end{bmatrix}$$

- ☐ system will have one solution
- ☒ system may have a solution ✓
- ☐ system does not have a solution

### Answer

Correct:

**rank**( $A$ ) = **2**, and  $m = 3$ . The rank is smaller than  $m$  so there might be a solution. If there is a solution, it will be unique since  $n = 2 = \mathbf{rank}(A)$ .

$$A = \begin{bmatrix} 3 & 1 & 2 \\ 1 & 0 & \frac{2}{3} \\ 6 & 1 & 4 \end{bmatrix}$$

- ☐ system will have one solution
- ☒ system may have a solution ✓
- ☐ system does not have a solution

**Answer**

Correct:

**rank**( $A$ ) = 2, and  $m = 3$ , so it may have a solution, which will not be unique, since  $n = 3 > \text{rank}(A)$ .

$$A = \begin{bmatrix} 3 & 1 & 2 \\ 1 & 0 & 2 \\ 6 & 1 & 4 \end{bmatrix}$$

- ☒ system will have one solution ✓
- ☐ system may have a solution
- ☐ system does not have a solution

**Answer**Correct: **rank**( $A$ ) = 3 =  $m = n$ Submit

✓ Correct (5/5 points)

**True or False**

2/2 points (ungraded)

Underdetermined systems do not have a solution.

✓ Answer: false

**Explanation**

If an underdetermined system is consistent, it will have an infinite number of solutions.

Underdetermined systems are always inconsistent.

✓ Answer: false

**Explanation**

A system is inconsistent if it does not have a solution.

✓ Correct (2/2 points)

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