Solving a matrix system using "slash"

Using the "slash":

- The solution to $AX = B$ is given by `X=A\B` (use the backslash).
- The solution to $XA = B$ is given by `X=B/A` (Forward slash).

Some examples to consider: If I type:

```
A=randn(100,7);
B=randn(3,7);
C=A/B
```

1. What size will C be? What matrix equation does C solve?

   SOLUTION: C will be 100×3, and using the forward slash template, we are solving the system: $CB = A$.

2. Instead of `C=A/B`, what would we type if we wanted to solve $CA = B$ for C?

   SOLUTION: `C=B/A`. In this case, C is 3×100.

3. Note some other differences between $CB = A$ and $CA = B$. It may be helpful to think of the matrix equations column wise- For example, the first equation can be thought of as:

   $$C\mathbf{b}_i = \mathbf{a}_i \qquad \text{for } i = 1:7$$

   Each of these 7 systems is *overdetermined* in that there are 100 equations in 3 unknowns.

   In the other system, we have:

   $$C\mathbf{a}_i = \mathbf{b}_i, \qquad \text{for } i = 1:7$$

   Each of these 7 systems is *underdetermined* in that there are only 3 equations but 100 variables.

4. Matlab handles overdetermined systems differently than underdetermined systems. In overdetermined systems, there is usually **no solution**, so that Matlab will give you the least squares solution using the pseudo-inverse.

   In an **underdetermined** system of equations, there is usually an infinite number of solutions (we ought to have a pivot in every row). Which solution does Matlab yield? If the matrix C is $m \times n$ so that $m < n$, then Matlab finds the solution with at most m non-zero entries. For example, solve $x + 3y + 4z = 1$ for x, y, z. In Matlab,

   ```
   A=[1;3;4]; B=1;
   C=B/A
   ```

   The vector C thus obtained is $[0, 0, 1/4]$.

5. Let A be 100×7 and let B be 3×7. Which of the following are defined and which will not be defined. If it is defined, what is the matrix equation you are solving?

(a) `A/B`

(b) `A\B`

(c) `B/A`

(d) `B\A`