Using Sage
Math 331

Starting with Section 1.3 (Vector Equations) you may use your calculator or a computer algebra system (CAS) to put matrices in REF/RREF and/or find their inverses (when they exist). For instance, you may choose to use the open-source CAS SageMath (aka, Sage). To use Sage, go to https://sagecell.sagemath.org/, enter your Sage code into the textbox, and click on Evaluate.

Creating and displaying a matrix:

- Sage represents an $m \times n$ matrix with an array (in square brackets) of $m$ entries, each of which is an array (in square brackets) of $n$ entries. If your matrix contains only rational entries, then you may define your matrix using code like that in the following example.

**Example.** To create the matrix
\[
A = \begin{bmatrix}
1 & -2 & 3 & 0 \\
0 & 2 & -8 & 8 \\
-4 & 5 & 9 & -9 \\
4 & 2 & 8 & -1/2
\end{bmatrix}
\]

enter
\[
A=\text{matrix}(\text{QQ},[[1,-2,3,0],[0,2,-8,8],[-4,5,9,-9], [4,2, 8, -1/2]])
\]

(If your matrix contains irrational entries, replace the QQ with RR, and if it contains complex numbers, replace the QQ with CC. In this class you won’t encounter such matrices requiring reduction.)

**Note:** Even if your matrix is augmented, you will not enter a vertical bar, and your resulting matrix will not display one; you just need to know it is there.

- To see the matrix $A$ that you have entered, enter `print(A)`.
- If you wish to insert a blank line, enter `print`.

Finding the RREF of a matrix:

- After you have entered in $A$, to display $A$’s RREF, enter `A.rref()`.

Finding the inverse of a matrix:

- After you have entered in $A$, to display $A$’s inverse, enter `A.inverse()`.

If $A$ is invertible, its inverse will be displayed. If it is singular, you will see an error message, ending with the line `ZeroDivisionError: input matrix must be nonsingular.`