03b.Row Reduction using SageMath

Here we recount the row reduction operations performed with the help of SageMath during a class. On the left panel we describe Sage and its operations. On the right panel we provide the matrices arising from row reduction steps, but typeset in LaTeX, with the augmentation bar added. The LaTeXsource will also be provided.

The script below provides SageMath commands that row reduce the matrix T "by hand". That is, the arithmetic, organization and update of matrix entries were done by the computer. But the choice of row reduction steps was made by a human. To run SageMath one can use the following web page:

https://sagecell.sagemath.org/

For a quick reference sheet for doing linear algebra with SageMath, look here (one long line, split-printed here):

wiki.sagemath.org/quickref?action=AttachFile&
do=view&target=quickref-linalg.pdf

or simply do a web search for the keyword string "sage quickref linear algebra". The book provides an introduction to SageMath. One can probably guess the meaning of each step, with a little help from the quick reference pages.

```
var( ' a,b,c ')
M=matrix( [[1,2,3,a],[4,5,6,b],[7,8,9,c]]); M
M.add˙multiple˙of˙row(1,0,-4) ;M
M.add˙multiple˙of˙row(2,0,-7) ;M
M.add˙multiple˙of˙row(2,1,-2) ; M
M.rescale˙row(1,1/3) ; M
M.add˙multiple˙of˙row(0,1,2) ; M
M.rescale˙row(1,-1) ; M
```

$$\left(\begin{array}{ccc|c} 1 & 2 & 3 & a \\ 4 & 5 & 6 & b \\ 7 & 8 & 9 & c \end{array}\right).$$

$$\left(\begin{array}{ccc|c} 1 & 2 & 3 & a \\ 0 & -3 & -6 & -4\,a+b \\ 7 & 8 & 9 & c \end{array}\right)$$

$$\left(\begin{array}{ccc|c} 1 & 2 & 3 & a \\ 0 & -3 & -6 & -4\,a+b \\ 0 & -6 & -12 & -7\,a+c \end{array}\right)$$

$$\left(\begin{array}{ccc|c} 1 & 2 & 3 & a \\ 0 & -3 & -6 & -4\,a+b \\ 0 & 0 & 0 & a-2\,b+c \end{array}\right)$$

$$\left(\begin{array}{ccc|c} 1 & 2 & 3 & a \\ 0 & -1 & -2 & -\frac{4}{3}\,a+\frac{1}{3}\,b \\ 0 & 0 & 0 & a-2\,b+c \end{array}\right)$$

$$\left(\begin{array}{ccc|c} 1 & 0 & -1 & -\frac{5}{3}\,a+\frac{2}{3}\,b \\ 0 & -1 & -2 & -\frac{4}{3}\,a+\frac{1}{3}\,b \\ 0 & 0 & 0 & a-2\,b+c \end{array}\right)$$

$$\left(\begin{array}{ccc|c} 1 & 0 & -1 & -\frac{5}{3}\,a+\frac{2}{3}\,b \\ 0 & 1 & 2 & \frac{4}{3}\,a-\frac{1}{3}\,b \\ 0 & 0 & 0 & a-2\,b+c \end{array}\right)$$