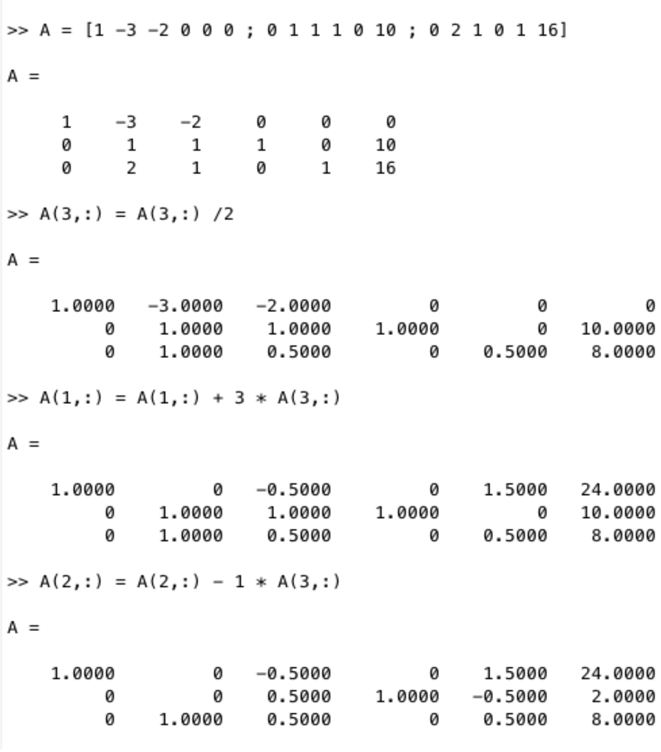
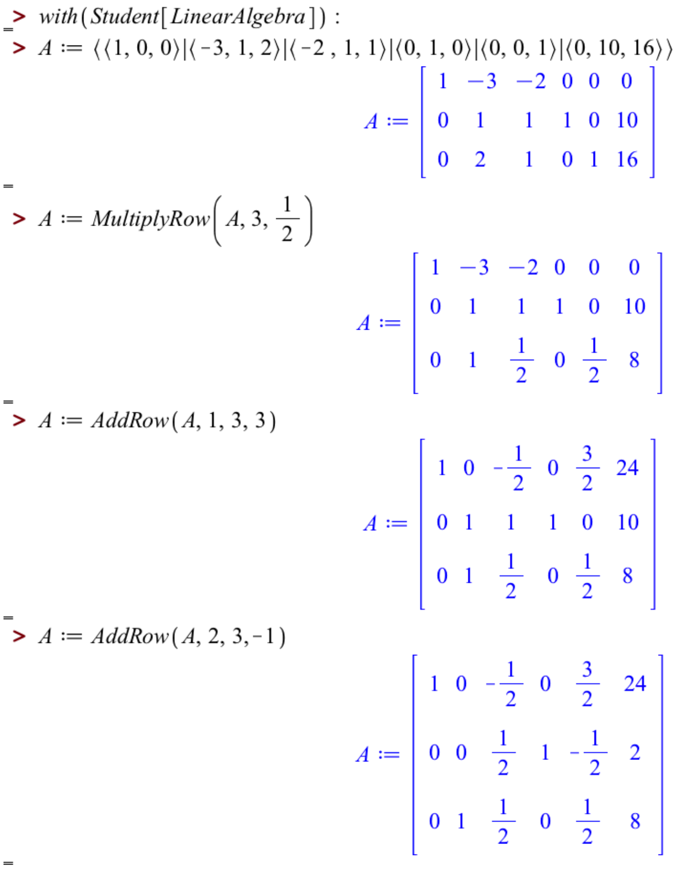
Performing Row Operations: Almost any tool will work to make the arithmetic easier.

MATLAB/OCTAVE



```
>> A = [1 -3 -2 0 0 0 ; 0 1 1 1 0 10 ; 0 2 1 0 1 16]

A =

     1    -3    -2     0     0     0
     0     1     1     1     0    10
     0     2     1     0     1    16

>> A(3,:) = A(3,:) /2

A =

    1.0000   -3.0000   -2.0000         0         0         0
         0    1.0000    1.0000    1.0000         0   10.0000
         0    1.0000    0.5000         0    0.5000    8.0000

>> A(1,:) = A(1,:) + 3 * A(3,:)

A =

    1.0000         0   -0.5000         0    1.5000   24.0000
         0    1.0000    1.0000    1.0000         0   10.0000
         0    1.0000    0.5000         0    0.5000    8.0000

>> A(2,:) = A(2,:) - 1 * A(3,:)

A =

    1.0000         0   -0.5000         0    1.5000   24.0000
         0         0    0.5000    1.0000   -0.5000    2.0000
         0    1.0000    0.5000         0    0.5000    8.0000
```

MAPLE



> $with(Student[LinearAlgebra])$:

> $A := \langle\langle 1, 0, 0\rangle|\langle -3, 1, 2\rangle|\langle -2, 1, 1\rangle|\langle 0, 1, 0\rangle|\langle 0, 0, 1\rangle|\langle 0, 10, 16\rangle\rangle$

$$A := \begin{bmatrix} 1 & -3 & -2 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 10 \\ 0 & 2 & 1 & 0 & 1 & 16 \end{bmatrix}$$

> $A := MultiplyRow\left(A, 3, \frac{1}{2}\right)$

$$A := \begin{bmatrix} 1 & -3 & -2 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 10 \\ 0 & 1 & \frac{1}{2} & 0 & \frac{1}{2} & 8 \end{bmatrix}$$

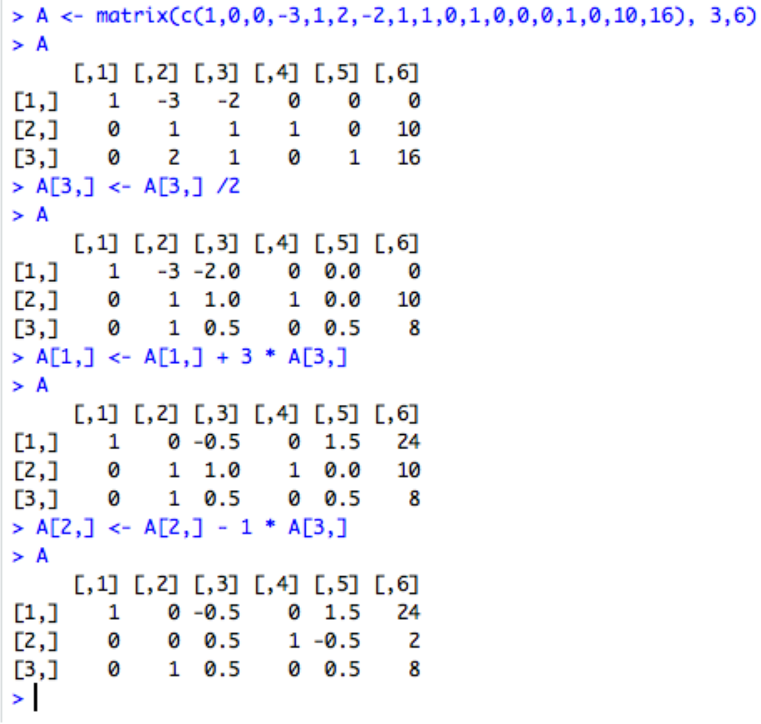
> $A := AddRow(A, 1, 3, 3)$

$$A := \begin{bmatrix} 1 & 0 & -\frac{1}{2} & 0 & \frac{3}{2} & 24 \\ 0 & 1 & 1 & 1 & 0 & 10 \\ 0 & 1 & \frac{1}{2} & 0 & \frac{1}{2} & 8 \end{bmatrix}$$

> $A := AddRow(A, 2, 3, -1)$

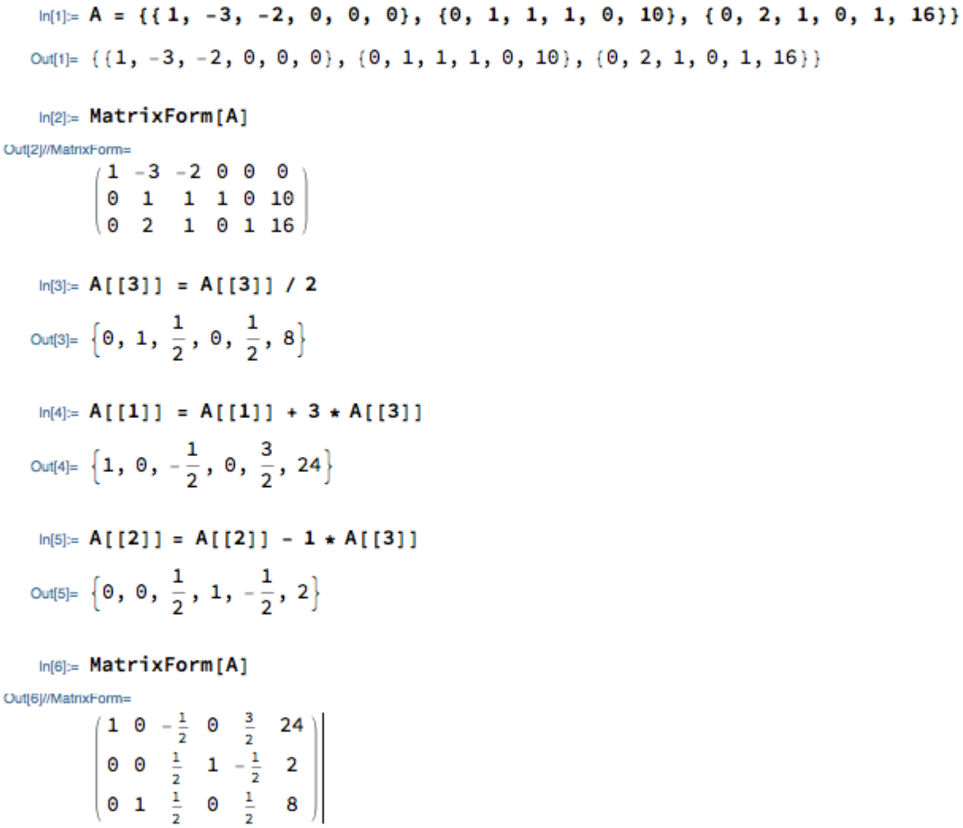
$$A := \begin{bmatrix} 1 & 0 & -\frac{1}{2} & 0 & \frac{3}{2} & 24 \\ 0 & 0 & \frac{1}{2} & 1 & -\frac{1}{2} & 2 \\ 0 & 1 & \frac{1}{2} & 0 & \frac{1}{2} & 8 \end{bmatrix}$$

R (R-STUDIO)



```
> A <- matrix(c(1,0,0,-3,1,2,-2,1,1,0,1,0,0,0,1,0,10,16), 3,6)
> A
     [,1] [,2] [,3] [,4] [,5] [,6]
[1,]    1   -3   -2    0    0    0
[2,]    0    1    1    1    0   10
[3,]    0    2    1    0    1   16
> A[3,] <- A[3,] /2
> A
     [,1] [,2] [,3] [,4] [,5] [,6]
[1,]    1   -3 -2.0    0  0.0    0
[2,]    0    1  1.0    1  0.0   10
[3,]    0    1  0.5    0  0.5    8
> A[1,] <- A[1,] + 3 * A[3,]
> A
     [,1] [,2] [,3] [,4] [,5] [,6]
[1,]    1    0 -0.5    0  1.5   24
[2,]    0    1  1.0    1  0.0   10
[3,]    0    1  0.5    0  0.5    8
> A[2,] <- A[2,] - 1 * A[3,]
> A
     [,1] [,2] [,3] [,4] [,5] [,6]
[1,]    1    0 -0.5    0  1.5   24
[2,]    0    0  0.5    1 -0.5    2
[3,]    0    1  0.5    0  0.5    8
> 
```

MATHEMATICA



```
In[1]:= A = {{ 1, -3, -2, 0, 0, 0}, {0, 1, 1, 1, 0, 10}, { 0, 2, 1, 0, 1, 16}}

Out[1]= {{1, -3, -2, 0, 0, 0}, {0, 1, 1, 1, 0, 10}, {0, 2, 1, 0, 1, 16}}

In[2]:= MatrixForm[A]
```

Out[2]//MatrixForm=

$$\begin{pmatrix} 1 & -3 & -2 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 10 \\ 0 & 2 & 1 & 0 & 1 & 16 \end{pmatrix}$$

```
In[3]:= A[[3]] = A[[3]] / 2
```

Out[3]= $\left\{0, 1, \frac{1}{2}, 0, \frac{1}{2}, 8\right\}$

```
In[4]:= A[[1]] = A[[1]] + 3 * A[[3]]
```

Out[4]= $\left\{1, 0, -\frac{1}{2}, 0, \frac{3}{2}, 24\right\}$

```
In[5]:= A[[2]] = A[[2]] - 1 * A[[3]]
```

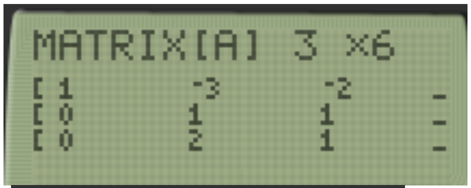
Out[5]= $\left\{0, 0, \frac{1}{2}, 1, -\frac{1}{2}, 2\right\}$

```
In[6]:= MatrixForm[A]
```

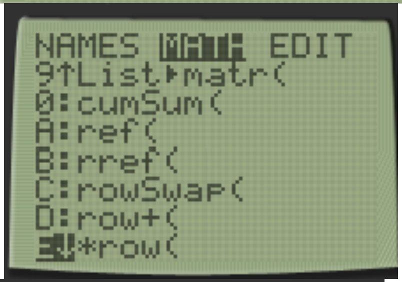
Out[6]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & -\frac{1}{2} & 0 & \frac{3}{2} & 24 \\ 0 & 0 & \frac{1}{2} & 1 & -\frac{1}{2} & 2 \\ 0 & 1 & \frac{1}{2} & 0 & \frac{1}{2} & 8 \end{pmatrix}$$

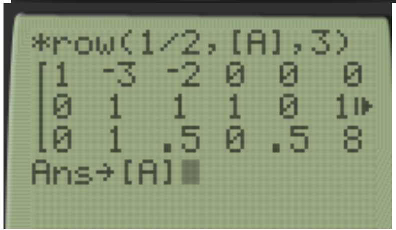
TI-CALCULATOR



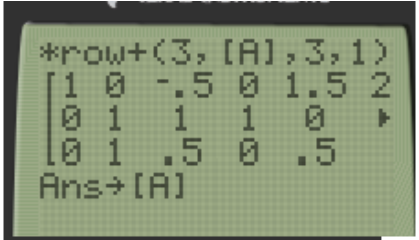
```
MATRIX[A] 3 ×6
[ 1      ⁻3      ⁻2     _
[ 0       1       1     _
[ 0       2       1     _
```



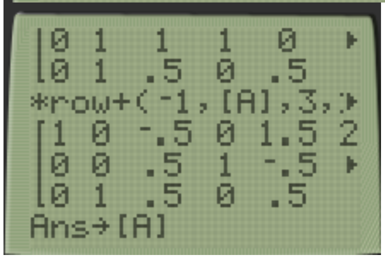
```
NAMES MATH EDIT
9↑List▸matr(
0:cumSum(
A:ref(
B:rref(
C:rowSwap(
D:row+(
E↓*row(
```



```
*row(1/2,[A],3)
[1  -3  -2  0  0   0
|0   1   1  1  0   1▸
[0   1  .5  0 .5   8
Ans→[A]
```

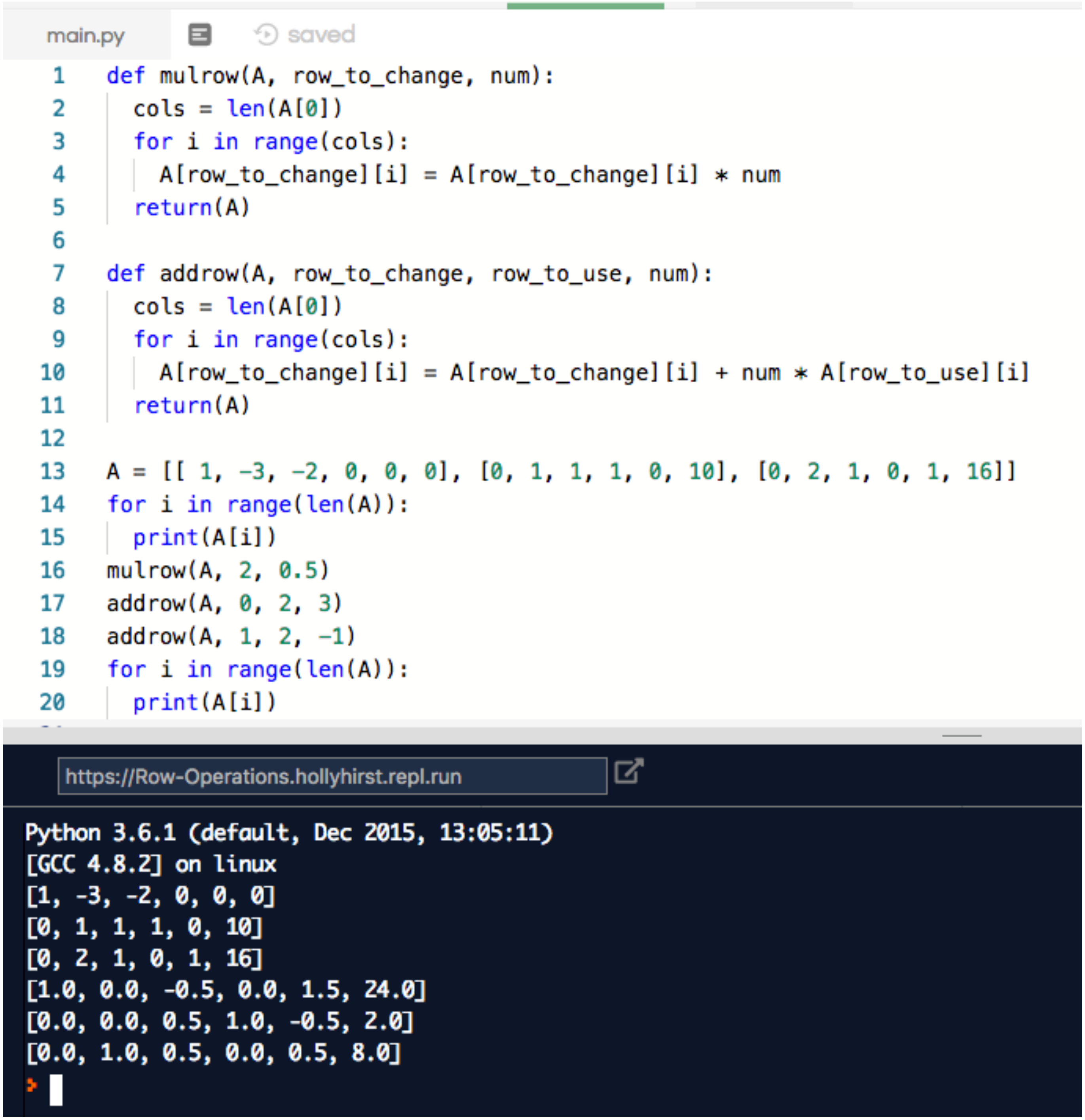


```
*row+(3,[A],3,1)
[1 0 -.5 0 1.5 2
|0 1   1 1   0 ▸
[0 1  .5 0  .5
Ans→[A]
```



```
|0 1  1  1  0  ▸
[0 1 .5  0 .5
*row+(-1,[A],3,▸
[1 0 -.5 0 1.5 2
|0 0  .5 1 -.5 ▸
[0 1  .5 0  .5
Ans→[A]
```

PYTHON



```python
def mulrow(A, row_to_change, num):
  cols = len(A[0])
  for i in range(cols):
    A[row_to_change][i] = A[row_to_change][i] * num
  return(A)

def addrow(A, row_to_change, row_to_use, num):
  cols = len(A[0])
  for i in range(cols):
    A[row_to_change][i] = A[row_to_change][i] + num * A[row_to_use][i]
  return(A)

A = [[ 1, -3, -2, 0, 0, 0], [0, 1, 1, 1, 0, 10], [0, 2, 1, 0, 1, 16]]
for i in range(len(A)):
  print(A[i])
mulrow(A, 2, 0.5)
addrow(A, 0, 2, 3)
addrow(A, 1, 2, -1)
for i in range(len(A)):
  print(A[i])
```

```
Python 3.6.1 (default, Dec 2015, 13:05:11)
[GCC 4.8.2] on linux
[1, -3, -2, 0, 0, 0]
[0, 1, 1, 1, 0, 10]
[0, 2, 1, 0, 1, 16]
[1.0, 0.0, -0.5, 0.0, 1.5, 24.0]
[0.0, 0.0, 0.5, 1.0, -0.5, 2.0]
[0.0, 1.0, 0.5, 0.0, 0.5, 8.0]
>
```