# Visual Null Space and Row Space

Start with the standard first line

```
> restart: with(LinearAlgebra): with(plots):
Warning, the name changecoords has been redefined
```

We want a routine that will plot a subspace given basis, dimension and color.

```
> Subspaceplot := proc (SBasis, SDim,SColor)
    local A, s, t;
    if SDim = 0 then A := pointplot3d([0,0,0],
         symbol=box,symbolsize=20,color=SColor):
      elif SDim = 1 then A := spacecurve(SBasis[1]*t, t = -5 .. 5,
   color=SColor):
      elif SDim = 2 then A := plot3d(SBasis[1]*t+SBasis[2]*s,
          s = -5 .. 5, t = -5 .. 5,color=SColor):
      elif SDim = 3 then A := pointplot3d([0,0,0],
          symbol=box,symbolsize=200,color=SColor,transparency=.8):
    end if;
   A:
   end proc:
```

We want to be able to generate the matrix A with a specified rank.

```
> A:= ZeroMatrix(3);
```

$$A := \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \tag{1}$$

```
> A1 := RandomVector(3,generator=rand(-10..10));
  A := <rand(-10..10)()*A1|rand(-10..10)()*A1|rand(-10..10)()*A1>;
```

$$A1 := \begin{bmatrix} 4 \\ 2 \\ -5 \end{bmatrix}$$

$$A := \begin{bmatrix} -36 & 4 & -28 \\ -18 & 2 & -14 \\ 45 & -5 & 35 \end{bmatrix} \tag{2}$$

```
> A1 := RandomMatrix(2,3,generator=rand(-10..10));
  A := <A1, rand(-5..5)()*Row(A1,1)+rand(-5..5)()*Row(A1,2)>;
```

$$A1 := \begin{bmatrix} -5 & -6 & 6 \\ -3 & -6 & -9 \end{bmatrix}$$

(3)

$$A := \begin{bmatrix} -5 & -6 & 6 \\ -3 & -6 & -9 \\ 26 & 36 & -6 \end{bmatrix} \tag{3}$$

```
> A := LinearAlgebra:-RandomMatrix(3,3,generator=rand(-10..10));
```

$$A := \begin{bmatrix} 0 & 8 & 3 \\ 7 & 4 & -3 \\ -1 & 3 & 1 \end{bmatrix} \tag{4}$$

Given the matrix, we want to plot these two spaces together.

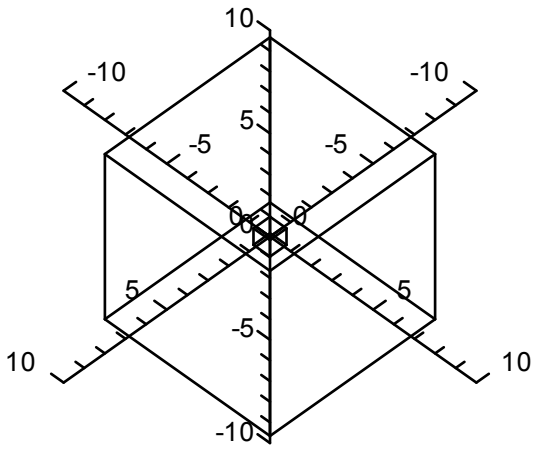
```
> NS := NullSpace(A);
  ND := 3-Rank(A);
  RS := RowSpace(A);
  RD := Rank(A);
  P1 := Subspaceplot(RS,RD,red):
  P2 := Subspaceplot(NS,ND,blue):
  display3d({P1,P2},view=[-10..10,-10..10,-10..10],axes=normal,
  scaling=constrained,style=patchnogrid);
```

$$NS := \{\}$$

$$ND := 0$$

$$RS := [[1 \quad 0 \quad 0], [0 \quad 1 \quad 0], [0 \quad 0 \quad 1]]$$

$$RD := 3$$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