# Custom functions

```
function r = gen_points_RS(RBV)
    r = [];
    for i = 1:10000
        k1 = -1 + 2*rand(1);
        k2 = -1 + 2*rand(1);
        r = [r,k1*RBV(1,:)'+k2*RBV(2,:)'];
    end
end

function r = gen_points_CS(CSV)
    r = [];
    for i = 1:10000
        k1 = -1 + 2*rand(1);
        k2 = -1 + 2*rand(1);
        r = [r,k1*CSV(:,1)+k2*CSV(:,2)];
    end
end

function r = Check_subspace(A,y)
    if(rank([A,y]) == rank(A))
        fprintf("This lies in column space")
    elseif(rank([A;(y')]) == rank(A))
        fprintf("This lies in row space")
    elseif(A*y == 0)
        fprintf("This lies in null space")
    else
        fprintf("This does not lie in a subspace")
    end
end
```

Q1

```
M = [1 0 0;0 0 0;0 0 3];
[RR, ic] = rref(M);
RBV = M(1:length(ic),:);
N = null(M);
RSpts = [];
NSpts = [];
for i = 1:1000
    k1 = -1 + 2*rand(1);
    k2 = -1 + 2*rand(1);
    RSpts = [RSpts,k1*RBV(1,:)'+k2*RBV(2,:)'];
    %NSpts = [NSpts,k1*NSV(1,:)]
end
scatter3(RSpts(1,:),RSpts(2,:),RSpts(3,:),1)
```
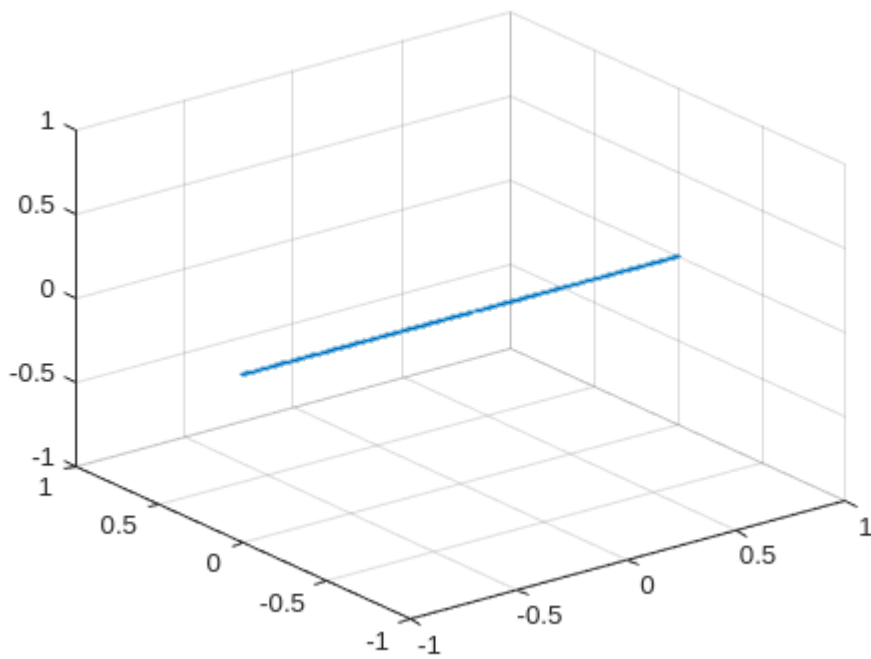
Q2

```
A = [1 4;0 5];
B = [0 0; 0 5];
C = zeros(2,2)
```

```
C = 2×2
     0     0
     0     0
```

```
N1 = null(A)
```

```
N1 =

  2×0 empty double matrix
```

```
N2 = null(B)
```

```
N2 = 2×1
     1
     0
```

```
N3 = null(C)
```

```
N3 = 2×2
     1     0
     0     1
```
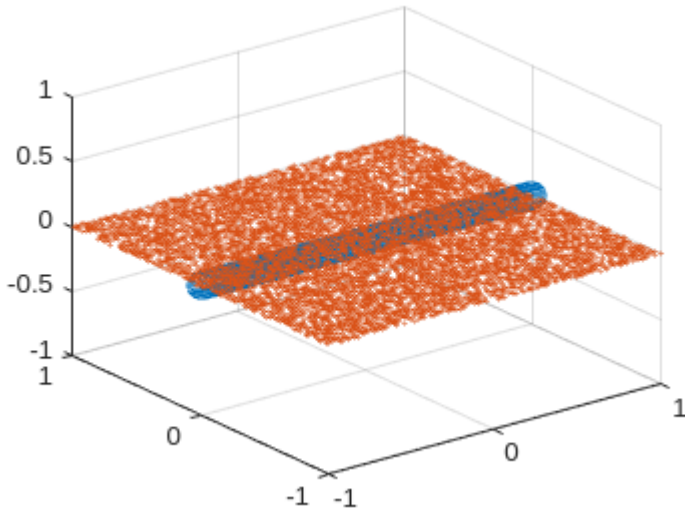
```
NSpts2 = gen_points_RS(N2)
```

```
NSpts2 = 1×10000
    0.3344   -0.4678    0.1425   -0.3522    0.3568    0.5791    0.9419   -0.1121 ⋯
```

```
NSpts3 = gen_points_RS(N3)
```

```
NSpts3 = 2×10000
    0.6669   -0.5325   -0.4771   -0.0170   -0.2015   -0.4273   -0.2226   -0.9715 ...
   -0.9970   -0.1029   -0.5537   -0.0574   -0.6529   -0.8264    0.0814    0.4528
```

```
clc
scatter3(NSpts2(1,:),zeros(1,10000),zeros(1,10000),100)
hold on
scatter3(NSpts3(1,:),NSpts3(2,:),zeros(1,10000),1)
hold off
```


Q3

```
M = randi([0 9],3,2)';
M(3,:) = randi([1 3])*M(1,:) + randi([1 3])*M(2,:);
[RR, ic] = rref(M);
RSBV = RR(1:length(ic),:);
CSBV = rref(M')
```

```
CSBV = 3×3
     1     0     3
     0     1     2
     0     0     0
```

```
RSpts = gen_points_RS(RSBV)
```

```
RSpts = 3×10000
    0.9345   -0.0296    0.0574    0.9725   -0.7522    0.7672    0.5160   -0.3010 ...
    0.0122   -0.8544   -0.3759    0.0694    0.1063    0.2401    0.1282   -0.8017
   -2.3956   -1.5319   -0.8560   -2.3863    2.1470   -1.5338   -1.0943   -0.7300
```

```
CSpts = gen_points_CS(CSBV)
```

```
CSpts = 3×10000
   -0.5988   -0.9900   -0.8831   -0.4747    0.6244   -0.3306   -0.9885    0.2827 ...
   -0.2551    0.9548    0.4387    0.7075    0.1560    0.0384    0.0348   -0.6842
```

```
scatter3(RSpts(1,:),RSpts(2,:),RSpts(3,:),1)
hold on
scatter3(CSpts(1,:),CSpts(2,:),CSpts(3,:),1)
hold off
```
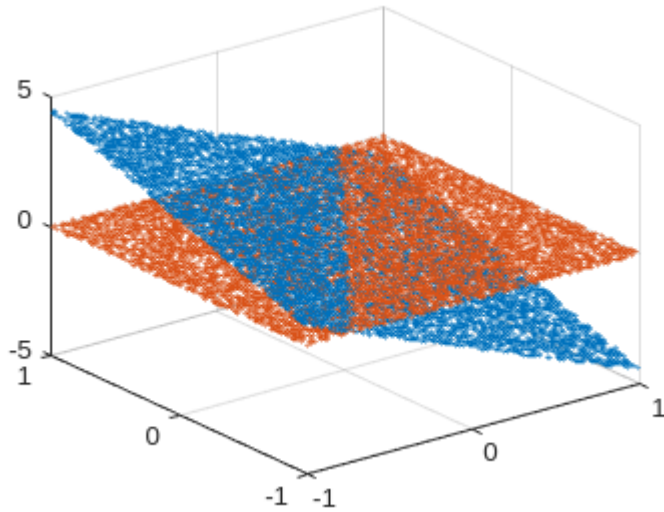

Q4

```
M = randi([0 9],3,1)';
M(2,:) = randi([1 3])*M(1,:);
M(3,:) = randi([1 3])*M(1,:) + randi([1 3])*M(2,:);
[RR, ic] = rref(M);
CS = rref(M')
```

```
CS = 3×3
     1     2     3
     0     0     0
     0     0     0
```

```
CSpts = gen_points_CS(CS)
```

```
CSpts = 3×10000
   -2.0794    0.5529   -1.0792    1.3231   -0.6619    0.3001    0.0825   -0.2279 ···
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
```

```
scatter3(CSpts(1,:),CSpts(2,:),CSpts(3,:),1)
hold on
LNS = null(M)
```
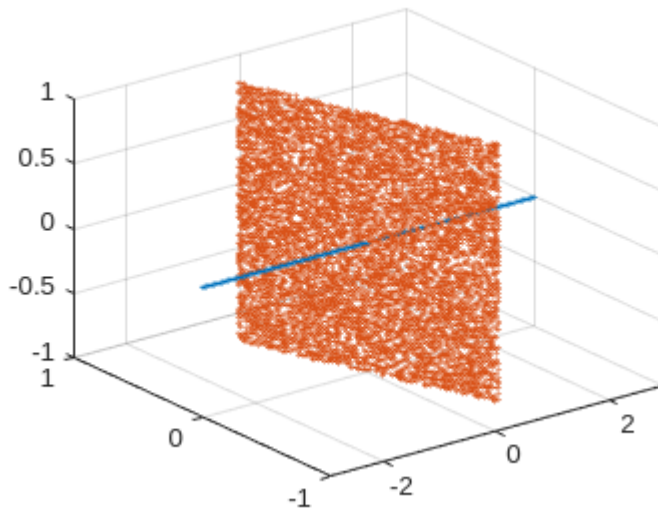
```
LNS = 3×2
   -0.7071        0
    0.7071        0
         0   1.0000
```

```
LNSPts = gen_points_CS(LNS)
```

```
LNSPts = 3×10000
    0.5521   -0.4098    0.6937    0.6437   -0.3835    0.4515   -0.2358    0.4013 ···
   -0.5521    0.4098   -0.6937   -0.6437    0.3835   -0.4515    0.2358   -0.4013
   -0.8660   -0.3070   -0.0598   -0.2757    0.8139    0.4473   -0.6004   -0.7376
```

```
scatter3(LNSPts(1,:),LNSPts(2,:),LNSPts(3,:),1)
hold off
```


Q5

```
A = [1 3 4 7; 2 4 6 10; 3 5 8 13; 4 6 10 16]
```

```
A = 4×4
     1     3     4     7
     2     4     6    10
     3     5     8    13
     4     6    10    16
```

```
u = [-2;-3;1;1]
```

```
u = 4×1
    -2
    -3
     1
     1
```

```
Check_subspace(A,u)
```

```
This lies in null space
```

```
v = [5;8;11;14];
Check_subspace(A,v)
```

```
This lies in column space
```

```
w = [1;1;2;3];
Check_subspace(A,w)
```

This lies in row space

```
y = [1;2;0;-1];
Check_subspace(A,y)
```

This lies in null space

```
m = [-1;1;1;-1];
Check_subspace(A,m)
```

Q6

```
A=[1 -1 2 3;0 2 1 4;1 1 3 1;2 0 5 4];

v=[5;1;-2;0];
Check_subspace(A,v)
```

This lies in null space

```
w=[0;2;2;2];
Check_subspace(A,w)
```

This lies in column space

```
u=[-1;2;-1;1];
Check_subspace(A,u)
```

This does not lie in a subspace

```
m=[3;-1;7;7];
Check_subspace(A,m)
```

This lies in row space