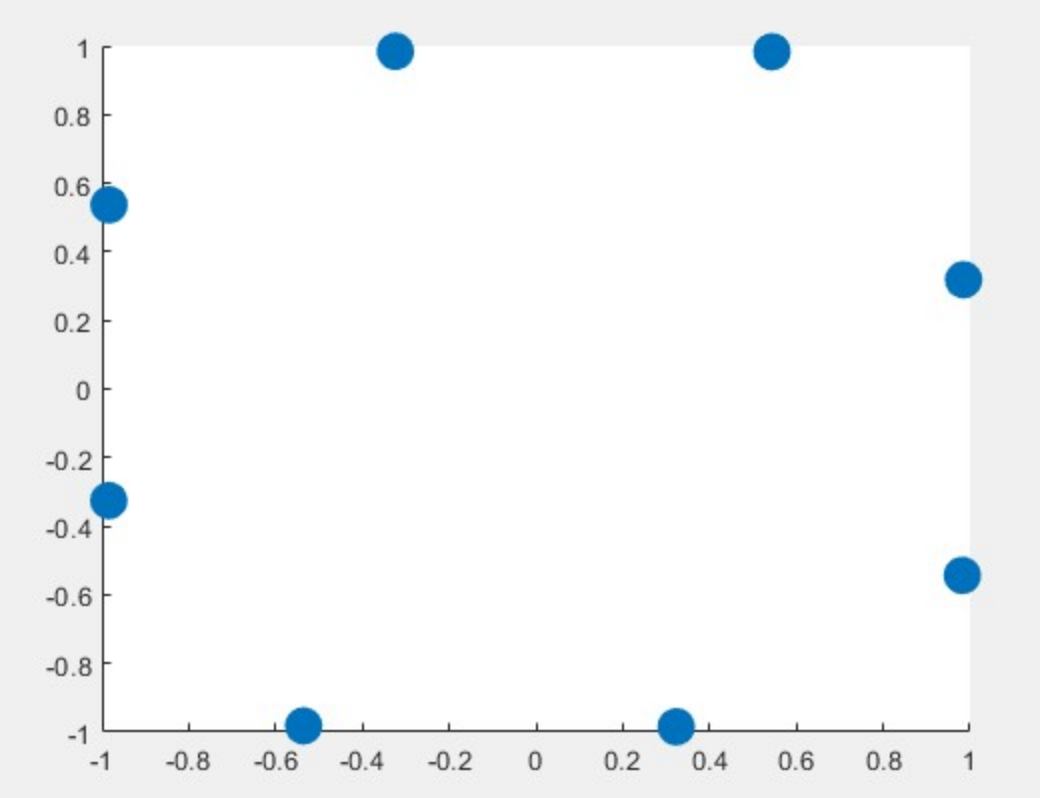
1. Use **bp3.m** to train an 8-2-8 autoencoder. Use eye(8) for the set of stimulus patterns (**p8.smat**).

a. For the targets, use **p8.tmat = eye(8)**

b. For **p8.tmat** field, try this: **i8 = eye(8) ; p8.tmat = i8 + i8([2 3 4 5 6 7 8 1] , :) + i8([8 1 2 3 4 5 6 7] , :) ;**

After checking the outputs for accuracy, examine the hidden unit representations.



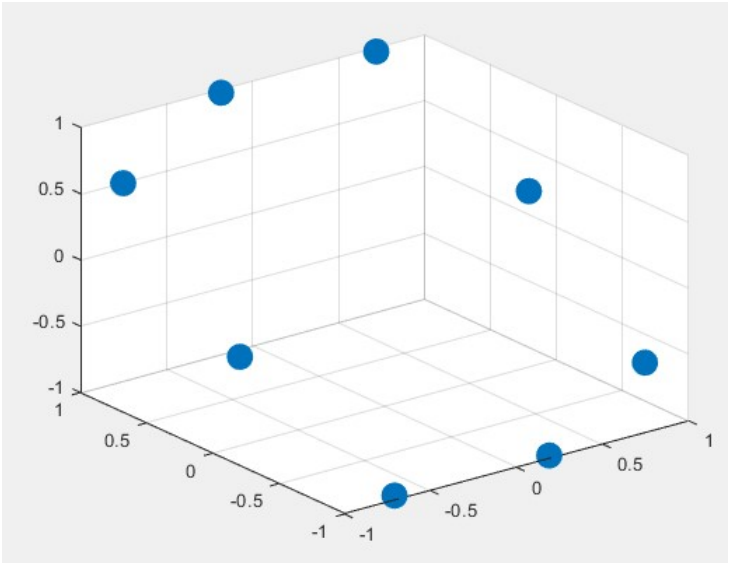
```
>> p8.smat=eye(8)

p8 =

  struct with fields:

    smat: [8×8 double]

>> p8.tmat=eye(8)

p8 =

  struct with fields:

    smat: [8×8 double]

    tmat: [8×8 double]

>> i8=eye(8);p8.tmat=i8+i8([2 3 4 5 6 7 8 1],:)+i8([8 1 2 3 4 5 6 7],:);

>> [p8.smat,p8.tmat]

ans =

  Columns 1 through 9

     1     0     0     0     0     0     0     0     1

     0     1     0     0     0     0     0     0     1

     0     0     1     0     0     0     0     0     0

     0     0     0     1     0     0     0     0     0

     0     0     0     0     1     0     0     0     0

     0     0     0     0     0     1     0     0     0

     0     0     0     0     0     0     1     0     0

     0     0     0     0     0     0     0     1     1

  Columns 10 through 16

     1     0     0     0     0     0     1

     1     1     0     0     0     0     0

     1     1     1     0     0     0     0

     0     1     1     1     0     0     0

     0     0     1     1     1     0     0

     0     0     0     1     1     1     0

     0     0     0     0     1     1     1

>> p8net0=initnet3(8,2,8,2,2)

p8net0 =

  struct with fields:

      wih: [2×8 double]

    hbias: [-0.1565 0.8315]

    whout: [8×2 double]

    obias: [1×8 double]

>> act0=forw3(p8net0,p8)

act0 =

  struct with fields:

     stim: [8×8 double]

      hid: [8×2 double]

      out: [8×8 double]

>> act0.stim

ans =

     1     0     0     0     0     0     0     0

     0     1     0     0     0     0     0     0

     0     0     1     0     0     0     0     0

     0     0     0     1     0     0     0     0

     0     0     0     0     1     0     0     0

     0     0     0     0     0     1     0     0

     0     0     0     0     0     0     1     0

     0     0     0     0     0     0     0     1

>> act0.hid

ans =

    0.2322    0.6759

   -0.4229    0.6800

    0.0541    0.0133

   -0.2911    0.4322

    0.3621    0.7067

   -0.3975    0.7096

    0.3618    0.3809

    0.2185    0.0576

>> act0.out

ans =

  Columns 1 through 5

    0.4155    0.6714    0.6620    0.2639    0.7927

    0.3269    0.5279    0.6152    0.3965    0.7079

    0.3170    0.6668    0.6012    0.3954    0.7198

    0.3174    0.5711    0.6067    0.4062    0.7058

    0.4377    0.6958    0.6731    0.2374    0.8092

    0.3334    0.5321    0.6193    0.3862    0.7141

    0.3991    0.7104    0.6504    0.2784    0.7875

    0.3430    0.6975    0.6167    0.3529    0.7459

  Columns 6 through 8

    0.2038    0.4155    0.3250

    0.1262    0.3596    0.2550

    0.2897    0.4728    0.4450

    0.1696    0.3967    0.3145

    0.2178    0.4235    0.3337

    0.1256    0.3587    0.2524

    0.2741    0.4593    0.4022

    0.3110    0.4825    0.4560
```

```
>> net20k=bp3(p8net0,p8,20000,.5,0)
net20k =
  struct with fields:
      wih: [2×8 double]
    hbias: [-0.1811 -0.1394]
    whout: [8×2 double]
    obias: [1×8 double]
>> ac20k=forw3(net20k,p8)
ac20k =
  struct with fields:
    stim: [8×8 double]
     hid: [8×2 double]
     out: [8×8 double]
>> ac20k.out
ans =
  Columns 1 through 5
    0.9996    0.9984    0.0012    0.0000    0.0000
    0.9994    1.0000    0.9994    0.0020    0.0000
    0.0012    0.9984    0.9996    0.9983    0.0012
    0.0000    0.0020    0.9994    1.0000    0.9994
    0.0000    0.0000    0.0012    0.9984    0.9995
    0.0000    0.0000    0.0000    0.0020    0.9994
    0.0012    0.0000    0.0000    0.0000    0.0012
    0.9994    0.0021    0.0000    0.0000    0.0000
  Columns 6 through 8
    0.0000    0.0012    0.9984
    0.0000    0.0000    0.0019
    0.0000    0.0000    0.0000
    0.0021    0.0000    0.0000
    0.9984    0.0012    0.0000
    1.0000    0.9995    0.0020
    0.9984    0.9996    0.9984
    0.0020    0.9994    1.0000
>> n0=initnet3(8,2,8,4,4)
n0 =
  struct with fields:
      wih: [2×8 double]
    hbias: [1.7708 -1.0444]
    whout: [8×2 double]
    obias: [1×8 double]
>> nf=bp3(n0,p8,20000,.02,0)
nf =
  struct with fields:
      wih: [2×8 double]
    hbias: [0.0712 0.0367]
    whout: [8×2 double]
    obias: [1×8 double]
>> act10k=forw3(nf,p8)
act10k =
  struct with fields:
    stim: [8×8 double]
     hid: [8×2 double]
     out: [8×8 double]
>> act10k.out
ans =
  Columns 1 through 5
    0.9979    0.9630    0.0406    0.0001    0.0000
    0.9601    0.9978    0.9723    0.0501    0.0001
    0.0478    0.9750    0.9977    0.9608    0.0374
    0.0001    0.0367    0.9599    0.9976    0.9744
    0.0000    0.0001    0.0534    0.9727    0.9980
    0.0001    0.0000    0.0001    0.0385    0.9633
    0.0375    0.0001    0.0000    0.0001    0.0480
    0.9739    0.0487    0.0001    0.0000    0.0000
  Columns 6 through 8
    0.0001    0.0503    0.9745
    0.0000    0.0001    0.0395
    0.0001    0.0000    0.0001
    0.0480    0.0001    0.0000
    0.9602    0.0422    0.0001
    0.9977    0.9737    0.0494
    0.9737    0.9976    0.9587
    0.0404    0.9572    0.9976
>> nf=bp3(n0,p8,20000,.05,0)
nf =
  struct with fields:
      wih: [2×8 double]
    hbias: [0.0699 0.0325]
    whout: [8×2 double]
    obias: [1×8 double]
>> act10k=forw3(nf,p8)
act10k =
  struct with fields:
    stim: [8×8 double]
     hid: [8×2 double]
     out: [8×8 double]
>> act10k.out
ans =
  Columns 1 through 5
    0.9998    0.9862    0.0166    0.0000    0.0000
    0.9833    0.9992    0.9882    0.0174    0.0000
    0.0206    0.9908    0.9998    0.9854    0.0159
    0.0000    0.0142    0.9831    0.9992    0.9879
    0.0000    0.0000    0.0228    0.9905    0.9998
    0.0000    0.0000    0.0000    0.0155    0.9829
    0.0169    0.0000    0.0000    0.0000    0.0222
    0.9887    0.0169    0.0000    0.0000    0.0000
  Columns 6 through 8
    0.0000    0.0215    0.9906
    0.0000    0.0000    0.0144
    0.0000    0.0000    0.0000
    0.0177    0.0000    0.0000
    0.9846    0.0176    0.0000
    0.9991    0.9879    0.0182
    0.9900    0.9998    0.9852
    0.0145    0.9823    0.9991
```

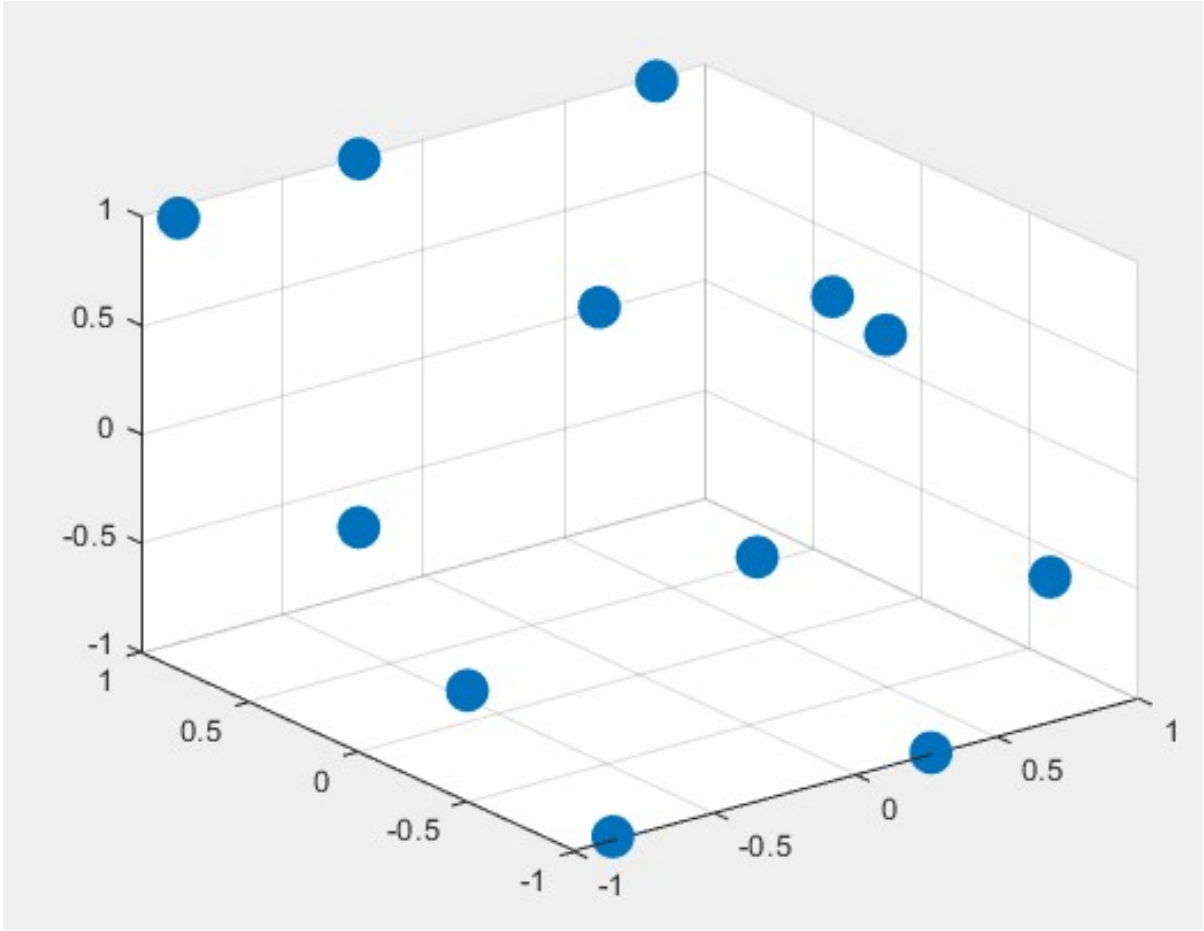
2. Use **bp3.m** to train an 8-3-8 autoencoder. Examine the hidden unit representations using scatter3.

```
>> p83n0=initnet3(8,2,8,4,4)

p83n0 =

  struct with fields:

      wih: [2×8 double]
    hbias: [0.3972 -0.4914]
    whout: [8×2 double]
    obias: [1×8 double]

>> p83nf=bp3(p83n0,p8,20000,.05,0)

p83nf =

  struct with fields:

      wih: [2×8 double]
    hbias: [-0.2642 -0.1833]
    whout: [8×2 double]
    obias: [1×8 double]

>> act10k=forw3(p83nf,p8)
act10k =

  struct with fields:

    stim: [8×8 double]
     hid: [8×2 double]
     out: [8×8 double]
```

```
>> p83act10k=act10k

p83act10k =

  struct with fields:

    stim: [8×8 double]
     hid: [8×2 double]
     out: [8×8 double]

>> act10k.out

ans =

  Columns 1 through 5

    0.9999    0.9925    0.0233    0.0000    0.0000
    0.9862    0.9980    0.9807    0.0152    0.0000
    0.0166    0.9880    0.9999    0.9925    0.0226
    0.0000    0.0164    0.9853    0.9982    0.9812
    0.0000    0.0000    0.0161    0.9890    0.9999
    0.0000    0.0000    0.0000    0.0156    0.9860
    0.0217    0.0000    0.0000    0.0000    0.0170
    0.9814    0.0142    0.0000    0.0000    0.0000

  Columns 6 through 8

    0.0000    0.0187    0.9881
    0.0000    0.0000    0.0166
    0.0000    0.0000    0.0000
    0.0146    0.0000    0.0000
    0.9930    0.0216    0.0000
    0.9983    0.9805    0.0151
    0.9887    0.9999    0.9922
    0.0155    0.9859    0.9979
```



3. Use **bp3.m** to train a 12-3-12 autoencoder. Examine the hidden unit representations using scatter3.



```
>> p12
p12 =
  struct with fields:
    smat: [12×12 double]
    tmat: [12×12 double]
>> p12net0=initnet3(12,3,12,4,4)
p12net0 =
  struct with fields:
      wih: [3×12 double]
    hbias: [-1.7519 -0.9220 0.8238]
    whout: [12×3 double]
    obias: [1×12 double]
>> p12act0=forw3(p12net0,p12)
p12act0 =
  struct with fields:
    stim: [12×12 double]
     hid: [12×3 double]
     out: [12×12 double]
>> p12act0.stim;
>>p12act0.out;
>> p12act0.hid
ans =
   -0.7382   -0.0460   -0.1553
   -0.8778   -0.8845    0.7575
   -0.8989   -0.6783    0.1984
   -0.8471    0.1930    0.3142
   -0.9290   -0.8544    0.3879
   -0.8594   -0.2849   -0.4730
   -0.2881    0.0018    0.6420
   -0.8840   -0.1215    0.8179
   -0.4321   -0.0243    0.8819
    0.0793    0.3004    0.1161
   -0.7397   -0.7786    0.4201
   -0.6043   -0.4407    0.7971
```

```
>> p12net20k=bp3(p12net0,p12,20000,.2,0)
p12net20k =
  struct with fields:
      wih: [3×12 double]
    hbias: [0.0639 0.0655 0.0717]
    whout: [12×3 double]
    obias: [1×12 double]
>> p12act20k=forw3(p12net20k,p12)
p12act20k =
  struct with fields:
    stim: [12×12 double]
     hid: [12×3 double]
     out: [12×12 double]
>> p12act20k.out
ans =
  Columns 1 through 5
    0.9992    0.9887    0.0039    0.0003    0.0006
    0.9945    1.0000    0.9970    0.0073    0.0000
    0.0075    0.9945    0.9986    0.9945    0.0062
    0.0000    0.0087    0.9955    1.0000    0.9962
    0.0029    0.0006    0.0051    0.9908    0.9994
    0.0000    0.0000    0.0000    0.0086    0.9926
    0.0000    0.0000    0.0000    0.0000    0.0104
    0.0000    0.0000    0.0000    0.0031    0.0002
    0.0000    0.0000    0.0053    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000    0.0000
    0.0084    0.0000    0.0000    0.0000    0.0000
    0.9927    0.0107    0.0000    0.0000    0.0000
  Columns 6 through 10
    0.0003    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0033    0.0020
    0.0000    0.0000    0.0000    0.0024    0.0000
    0.0067    0.0012    0.0033    0.0010    0.0000
    0.9912    0.0055    0.0000    0.0000    0.0000
    1.0000    0.9984    0.0063    0.0000    0.0000
    0.9979    1.0000    0.9902    0.0063    0.0006
    0.0026    0.9913    0.9979    0.9947    0.0048
    0.0000    0.0049    0.9956    1.0000    0.9987
    0.0000    0.0010    0.0109    0.9900    0.9971
    0.0001    0.0021    0.0000    0.0076    0.9942
    0.0048    0.0000    0.0000    0.0000    0.0068
  Columns 11 through 12
    0.0094    0.9899
    0.0005    0.0072
    0.0000    0.0000
    0.0000    0.0000
    0.0000    0.0006
    0.0000    0.0077
    0.0049    0.0001
    0.0000    0.0000
    0.0053    0.0000
    0.9903    0.0035
    1.0000    0.9955
    0.9962    1.0000
>> p12.tmat
ans =
     1     1     0     0     0     0     0     0     0     0     0     1
     1     1     1     0     0     0     0     0     0     0     0     0
     0     1     1     1     0     0     0     0     0     0     0     0
     0     0     1     1     1     0     0     0     0     0     0     0
     0     0     0     1     1     1     0     0     0     0     0     0
     0     0     0     0     1     1     1     0     0     0     0     0
     0     0     0     0     0     1     1     1     0     0     0     0
     0     0     0     0     0     0     1     1     1     0     0     0
     0     0     0     0     0     0     0     1     1     1     0     0
     0     0     0     0     0     0     0     0     1     1     1     0
     0     0     0     0     0     0     0     0     0     1     1     1
     1     0     0     0     0     0     0     0     0     0     1     1
```