```
% Main Script

% Set prototypes
orange_prototype = [1; -1; -1];
apple_prototype = [1; 1; -1];
prototypes = [orange_prototype, apple_prototype];

% Validate book example

test_fruit = [-1; -1; -1]; % Create test cases

hammingFruitClassifier = hammingNetwork(prototypes);
result = hammingFruitClassifier.classify(test_fruit, 0.5);
```

```
TF in Feed Forward Layer:
    @purelin

W in Feed Forward Layer:
    1    -1    -1
    1     1    -1

b in Feed Forward Layer:
    2
    2

Feed Forward Layer Result (a1):
    3
    1

TF in Recurrent Layer:
    @poslin

W in Recurrent Layer:
    1.0000   -0.5000
   -0.5000    1.0000

a(2) in Recurrent Layer:
    2.5000
         0

a(3) in Recurrent Layer:
    2.5000
         0

Hamming Network result:
    1
    0
```

```
classifyFruit(result)
```

```
The fruit is an Orange
```

```
% Compute exercice 1
% 1) Crear a W1 con S=7 y R=9, un solo valor de epsilon,
% proponga un valor de p desconocido y obtenga su resultado de
% clasificación.
```

1

```
fruit1_prototype = [1; 1; −1; −1; 1; −1; 1];
fruit2_prototype = [−1; 1; 1; −1; −1; 1; 1];
fruit3_prototype = [1; −1; 1; −1; 1; −1; 1];
fruit4_prototype = [1; 1; 1; −1; −1; −1; 1];
fruit5_prototype = [−1; −1; −1; 1; 1; −1; 1];
fruit6_prototype = [1; −1; −1; −1; 1; −1; −1];
fruit7_prototype = [1; 1; −1; 1; −1; 1; −1];
fruit8_prototype = [−1; 1; −1; 1; 1; 1; −1];
fruit9_prototype = [1; −1; 1; 1; −1; −1; 1];

prototypes_1 = [fruit1_prototype, fruit2_prototype, fruit3_prototype,
fruit4_prototype, fruit5_prototype, fruit6_prototype, fruit7_prototype,
fruit8_prototype, fruit9_prototype];

test_fruit_1 = [−1; 1; −1; −1; 1; 1; −1]; % Create test cases

hammingFruitClassifier_1 = hammingNetwork(prototypes_1);
result_1 = hammingFruitClassifier_1.classify(test_fruit_1, 0);
```

```
TF in Feed Forward Layer:
    @purelin

W in Feed Forward Layer:
     1     1    −1    −1     1    −1     1
    −1     1     1    −1    −1     1     1
     1    −1     1    −1     1    −1     1
     1     1     1    −1    −1    −1     1
    −1    −1    −1     1     1    −1     1
     1    −1    −1    −1     1    −1    −1
     1     1    −1     1    −1     1    −1
    −1     1    −1     1     1     1    −1
     1    −1     1     1    −1    −1     1

b in Feed Forward Layer:
     9
     9
     9
     9
     9
     9
     9
     9
     9

Feed Forward Layer Result (a1):
    10
    10
     6
     6
     8
    10
    10
    14
     2

TF in Recurrent Layer:
    @poslin
```

W in Recurrent Layer:

1.0000	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250
−0.1250	1.0000	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250
−0.1250	−0.1250	1.0000	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250
−0.1250	−0.1250	−0.1250	1.0000	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250
−0.1250	−0.1250	−0.1250	−0.1250	1.0000	−0.1250	−0.1250	−0.1250	−0.1250
−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	1.0000	−0.1250	−0.1250	−0.1250
−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	1.0000	−0.1250	−0.1250
−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	1.0000	−0.1250
−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	−0.1250	1.0000

a(2) in Recurrent Layer:
    1.7500
    1.7500
         0
         0
         0
    1.7500
    1.7500
    6.2500
         0

a(3) in Recurrent Layer:
    0.3125
    0.3125
         0
         0
         0
    0.3125
    0.3125
    5.3750
         0

a(4) in Recurrent Layer:
         0
         0
         0
         0
         0
         0
         0
    5.2188
         0

a(5) in Recurrent Layer:
         0
         0
         0
         0
         0
         0
         0
    5.2188
         0

Hamming Network result:
         0
         0
         0
         0
         0
         0
         0

```
      1
      0
```

```
classify_e1(result_1)
```

The fruit 8

```
% Compute excercie 2
%  2) Usar el W1 anterior y repetir el experimento para 3 valores
% de epsilon diferentes al anterior y el mismo valor de p del ejercicio
anterior.

result_2_1 = hammingFruitClassifier_1.classify(test_fruit_1, 0.1);
```

```
TF in Feed Forward Layer:
    @purelin

W in Feed Forward Layer:
     1     1    -1    -1     1    -1     1
    -1     1     1    -1    -1     1     1
     1    -1     1    -1     1    -1     1
     1     1     1    -1    -1    -1     1
    -1    -1    -1     1     1    -1     1
     1    -1    -1    -1     1    -1    -1
     1     1    -1     1    -1     1    -1
    -1     1    -1     1     1     1    -1
     1    -1     1     1    -1    -1     1

b in Feed Forward Layer:
     9
     9
     9
     9
     9
     9
     9
     9
     9

Feed Forward Layer Result (a1):
    10
    10
     6
     6
     8
    10
    10
    14
     2

TF in Recurrent Layer:
    @poslin

W in Recurrent Layer:
    1.0000   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250
   -0.0250    1.0000   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250
   -0.0250   -0.0250    1.0000   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250
   -0.0250   -0.0250   -0.0250    1.0000   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250
   -0.0250   -0.0250   -0.0250   -0.0250    1.0000   -0.0250   -0.0250   -0.0250   -0.0250
   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250    1.0000   -0.0250   -0.0250   -0.0250
   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250    1.0000   -0.0250   -0.0250
   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250    1.0000   -0.0250
```

```
   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250   -0.0250    1.0000
```

a(2) in Recurrent Layer:
```
    8.3500
    8.3500
    4.2500
    4.2500
    6.3000
    8.3500
    8.3500
   12.4500
    0.1500
```

a(3) in Recurrent Layer:
```
    7.0387
    7.0387
    2.8363
    2.8363
    4.9375
    7.0387
    7.0387
   11.2412
        0
```

a(4) in Recurrent Layer:
```
    5.9646
    5.9646
    1.6570
    1.6570
    3.8108
    5.9646
    5.9646
   10.2721
        0
```

a(5) in Recurrent Layer:
```
    5.0823
    5.0823
    0.6670
    0.6670
    2.8747
    5.0823
    5.0823
    9.4975
        0
```

a(6) in Recurrent Layer:
```
    4.3585
    4.3585
        0
        0
    2.0957
    4.3585
    4.3585
    8.8841
        0
```

a(7) in Recurrent Layer:
```
    3.7571
    3.7571
        0
        0
    1.4377
    3.7571
```

```
    3.7571
    8.3959
         0

a(8) in Recurrent Layer:
    3.2295
    3.2295
         0
         0
    0.8521
    3.2295
    3.2295
    7.9842
         0

a(9) in Recurrent Layer:
    2.7664
    2.7664
         0
         0
    0.3295
    2.7664
    2.7664
    7.6400
         0

a(10) in Recurrent Layer:
    2.3596
    2.3596
         0
         0
         0
    2.3596
    2.3596
    7.3551
         0

a(11) in Recurrent Layer:
    1.9988
    1.9988
         0
         0
         0
    1.9988
    1.9988
    7.1191
         0

a(12) in Recurrent Layer:
    1.6709
    1.6709
         0
         0
         0
    1.6709
    1.6709
    6.9192
         0

a(13) in Recurrent Layer:
    1.3726
    1.3726
         0
         0
```

```
        0
   1.3726
   1.3726
   6.7522
        0

a(14) in Recurrent Layer:
   1.1009
   1.1009
        0
        0
        0
   1.1009
   1.1009
   6.6149
        0

a(15) in Recurrent Layer:
   0.8529
   0.8529
        0
        0
        0
   0.8529
   0.8529
   6.5048
        0

a(16) in Recurrent Layer:
   0.6263
   0.6263
        0
        0
        0
   0.6263
   0.6263
   6.4195
        0

a(17) in Recurrent Layer:
   0.4189
   0.4189
        0
        0
        0
   0.4189
   0.4189
   6.3569
        0

a(18) in Recurrent Layer:
   0.2285
   0.2285
        0
        0
        0
   0.2285
   0.2285
   6.3150
        0

a(19) in Recurrent Layer:
   0.0535
   0.0535
```

```
              0
              0
              0
         0.0535
         0.0535
         6.2921
              0

a(20) in Recurrent Layer:
              0
              0
              0
              0
              0
              0
              0
         6.2868
              0

a(21) in Recurrent Layer:
              0
              0
              0
              0
              0
              0
              0
         6.2868
              0

Hamming Network result:
         0
         0
         0
         0
         0
         0
         0
         1
         0
```

```
result_2_2 = hammingFruitClassifier_1.classify(test_fruit_1, 0.01);
```

```
TF in Feed Forward Layer:
    @purelin

W in Feed Forward Layer:
     1     1    -1    -1     1    -1     1
    -1     1     1    -1    -1     1     1
     1    -1     1    -1     1    -1     1
     1     1     1    -1    -1    -1     1
    -1    -1    -1     1     1    -1     1
     1    -1    -1    -1     1    -1    -1
     1     1    -1     1    -1     1    -1
    -1     1    -1     1     1     1    -1
     1    -1     1     1    -1    -1     1

b in Feed Forward Layer:
     9
     9
     9
     9
     9
```

```
        9
        9
        9
        9

Feed Forward Layer Result (a1):
       10
       10
        6
        6
        8
       10
       10
       14
        2

TF in Recurrent Layer:
    @poslin

W in Recurrent Layer:
    1.0000    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150
   -0.1150     1.0000    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150
   -0.1150    -0.1150     1.0000    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150
   -0.1150    -0.1150    -0.1150     1.0000    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150
   -0.1150    -0.1150    -0.1150    -0.1150     1.0000    -0.1150    -0.1150    -0.1150    -0.1150
   -0.1150    -0.1150    -0.1150    -0.1150    -0.1150     1.0000    -0.1150    -0.1150    -0.1150
   -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150     1.0000    -0.1150    -0.1150
   -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150     1.0000    -0.1150
   -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150    -0.1150     1.0000

a(2) in Recurrent Layer:
    2.4100
    2.4100
         0
         0
    0.1800
    2.4100
    2.4100
    6.8700
         0

a(3) in Recurrent Layer:
    0.7678
    0.7678
         0
         0
         0
    0.7678
    0.7678
    5.7407
         0

a(4) in Recurrent Layer:
         0
         0
         0
         0
         0
         0
         0
    5.3875
         0

a(5) in Recurrent Layer:
```

```
        0
        0
        0
        0
        0
        0
        0
   5.3875
        0
```

Hamming Network result:
```
     0
     0
     0
     0
     0
     0
     0
     1
     0
```

result_2_3 = hammingFruitClassifier_1.classify(test_fruit_1, −0.1);

TF in Feed Forward Layer:
    @purelin

W in Feed Forward Layer:
```
    1     1    −1    −1     1    −1     1
   −1     1     1    −1    −1     1     1
    1    −1     1    −1     1    −1     1
    1     1     1    −1    −1    −1     1
   −1    −1    −1     1     1    −1     1
    1    −1    −1    −1     1    −1    −1
    1     1    −1     1    −1     1    −1
   −1     1    −1     1     1     1    −1
    1    −1     1     1    −1    −1     1
```

b in Feed Forward Layer:
```
     9
     9
     9
     9
     9
     9
     9
     9
     9
```

Feed Forward Layer Result (a1):
```
    10
    10
     6
     6
     8
    10
    10
    14
     2
```

TF in Recurrent Layer:
    @poslin

W in Recurrent Layer:

10

```
     1.0000    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250
    -0.2250     1.0000    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250
    -0.2250    -0.2250     1.0000    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250
    -0.2250    -0.2250    -0.2250     1.0000    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250
    -0.2250    -0.2250    -0.2250    -0.2250     1.0000    -0.2250    -0.2250    -0.2250    -0.2250
    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250     1.0000    -0.2250    -0.2250    -0.2250
    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250     1.0000    -0.2250    -0.2250
    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250     1.0000    -0.2250
    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250    -0.2250     1.0000

a(2) in Recurrent Layer:
         0
         0
         0
         0
         0
         0
         0
    0.0500
         0

a(3) in Recurrent Layer:
         0
         0
         0
         0
         0
         0
         0
    0.0500
         0

Hamming Network result:
     0
     0
     0
     0
     0
     0
     0
     1
     0
```

```
classify_e1(result_2_1)
```

The fruit 8

```
classify_e1(result_2_2)
```

The fruit 8

```
classify_e1(result_2_3)
```

The fruit 8

```
% Compute ecercise 3
% 3) Crear un W1 con cualquier S, R y epsilon de tal manera que a2 se
% quede oscilando use un máximo de iteraciones para detener el programa,
itmax=100.
```

```
test1_prototype = [1; -1; -1; 1; 1];
test2_prototype = [1; 1; -1; 1; -1];
test3_prototype = [-1; -1; -1; 1; -1];
prototypes_3 = [test1_prototype, test2_prototype, test3_prototype];

% Validate book example

test_p_e3 = [-1; -1; -1; 1; 1]; % Create test cases

hammingFruitClassifier_3 = hammingNetwork(prototypes_3);
result_3 = hammingFruitClassifier_3.classify(test_p_e3, 0);
```

```
TF in Feed Forward Layer:
    @purelin

W in Feed Forward Layer:
     1    -1    -1     1     1
     1     1    -1     1    -1
    -1    -1    -1     1    -1

b in Feed Forward Layer:
     3
     3
     3

Feed Forward Layer Result (a1):
     6
     2
     6

TF in Recurrent Layer:
    @poslin

W in Recurrent Layer:
    1.0000   -0.5000   -0.5000
   -0.5000    1.0000   -0.5000
   -0.5000   -0.5000    1.0000

a(2) in Recurrent Layer:
     2
     0
     2

a(3) in Recurrent Layer:
     1
     0
     1

a(4) in Recurrent Layer:
    0.5000
         0
    0.5000

a(5) in Recurrent Layer:
    0.2500
         0
    0.2500

a(6) in Recurrent Layer:
    0.1250
         0
```

```
    0.1250

a(7) in Recurrent Layer:
    0.0625
         0
    0.0625

a(8) in Recurrent Layer:
    0.0312
         0
    0.0312

a(9) in Recurrent Layer:
    0.0156
         0
    0.0156

a(10) in Recurrent Layer:
    0.0078
         0
    0.0078

a(11) in Recurrent Layer:
    0.0039
         0
    0.0039

a(12) in Recurrent Layer:
    0.0020
         0
    0.0020

a(13) in Recurrent Layer:
   1.0e-03 *

    0.9766
         0
    0.9766

a(14) in Recurrent Layer:
   1.0e-03 *

    0.4883
         0
    0.4883

a(15) in Recurrent Layer:
   1.0e-03 *

    0.2441
         0
    0.2441

a(16) in Recurrent Layer:
   1.0e-03 *

    0.1221
         0
    0.1221

a(17) in Recurrent Layer:
   1.0e-04 *

    0.6104
```

```
        0
   0.6104

a(18) in Recurrent Layer:
   1.0e-04 *

   0.3052
        0
   0.3052

a(19) in Recurrent Layer:
   1.0e-04 *

   0.1526
        0
   0.1526

a(20) in Recurrent Layer:
   1.0e-05 *

   0.7629
        0
   0.7629

a(21) in Recurrent Layer:
   1.0e-05 *

   0.3815
        0
   0.3815

a(22) in Recurrent Layer:
   1.0e-05 *

   0.1907
        0
   0.1907

a(23) in Recurrent Layer:
   1.0e-06 *

   0.9537
        0
   0.9537

a(24) in Recurrent Layer:
   1.0e-06 *

   0.4768
        0
   0.4768

a(25) in Recurrent Layer:
   1.0e-06 *

   0.2384
        0
   0.2384

a(26) in Recurrent Layer:
   1.0e-06 *

   0.1192
        0
```

```
     0.1192

a(27) in Recurrent Layer:
   1.0e-07 *

     0.5960
          0
     0.5960

a(28) in Recurrent Layer:
   1.0e-07 *

     0.2980
          0
     0.2980

a(29) in Recurrent Layer:
   1.0e-07 *

     0.1490
          0
     0.1490

a(30) in Recurrent Layer:
   1.0e-08 *

     0.7451
          0
     0.7451

a(31) in Recurrent Layer:
   1.0e-08 *

     0.3725
          0
     0.3725

a(32) in Recurrent Layer:
   1.0e-08 *

     0.1863
          0
     0.1863

a(33) in Recurrent Layer:
   1.0e-09 *

     0.9313
          0
     0.9313

a(34) in Recurrent Layer:
   1.0e-09 *

     0.4657
          0
     0.4657

a(35) in Recurrent Layer:
   1.0e-09 *

     0.2328
          0
     0.2328
```

```
a(36) in Recurrent Layer:
   1.0e-09 *

     0.1164
          0
     0.1164

a(37) in Recurrent Layer:
   1.0e-10 *

     0.5821
          0
     0.5821

a(38) in Recurrent Layer:
   1.0e-10 *

     0.2910
          0
     0.2910

a(39) in Recurrent Layer:
   1.0e-10 *

     0.1455
          0
     0.1455

a(40) in Recurrent Layer:
   1.0e-11 *

     0.7276
          0
     0.7276

a(41) in Recurrent Layer:
   1.0e-11 *

     0.3638
          0
     0.3638

a(42) in Recurrent Layer:
   1.0e-11 *

     0.1819
          0
     0.1819

a(43) in Recurrent Layer:
   1.0e-12 *

     0.9095
          0
     0.9095

a(44) in Recurrent Layer:
   1.0e-12 *

     0.4547
          0
     0.4547
```

a(45) in Recurrent Layer:

    1.0e-12 *

      0.2274
           0
      0.2274

a(46) in Recurrent Layer:

    1.0e-12 *

      0.1137
           0
      0.1137

a(47) in Recurrent Layer:

    1.0e-13 *

      0.5684
           0
      0.5684

a(48) in Recurrent Layer:

    1.0e-13 *

      0.2842
           0
      0.2842

a(49) in Recurrent Layer:

    1.0e-13 *

      0.1421
           0
      0.1421

a(50) in Recurrent Layer:

    1.0e-14 *

      0.7105
           0
      0.7105

a(51) in Recurrent Layer:

    1.0e-14 *

      0.3553
           0
      0.3553

a(52) in Recurrent Layer:

    1.0e-14 *

      0.1776
           0
      0.1776

a(53) in Recurrent Layer:

    1.0e-15 *

      0.8882
           0
      0.8882

a(54) in Recurrent Layer:

```
    1.0e-15 *

    0.4441
         0
    0.4441

a(55) in Recurrent Layer:
    1.0e-15 *

    0.2220
         0
    0.2220

a(56) in Recurrent Layer:
    1.0e-15 *

    0.1110
         0
    0.1110

a(57) in Recurrent Layer:
    1.0e-16 *

    0.5551
         0
    0.5551

a(58) in Recurrent Layer:
    1.0e-16 *

    0.2776
         0
    0.2776

a(59) in Recurrent Layer:
    1.0e-16 *

    0.1388
         0
    0.1388

a(60) in Recurrent Layer:
    1.0e-17 *

    0.6939
         0
    0.6939

a(61) in Recurrent Layer:
    1.0e-17 *

    0.3469
         0
    0.3469

a(62) in Recurrent Layer:
    1.0e-17 *

    0.1735
         0
    0.1735

a(63) in Recurrent Layer:
    1.0e-18 *
```

```
    0.8674
         0
    0.8674

a(64) in Recurrent Layer:
    1.0e-18 *

    0.4337
         0
    0.4337

a(65) in Recurrent Layer:
    1.0e-18 *

    0.2168
         0
    0.2168

a(66) in Recurrent Layer:
    1.0e-18 *

    0.1084
         0
    0.1084

a(67) in Recurrent Layer:
    1.0e-19 *

    0.5421
         0
    0.5421

a(68) in Recurrent Layer:
    1.0e-19 *

    0.2711
         0
    0.2711

a(69) in Recurrent Layer:
    1.0e-19 *

    0.1355
         0
    0.1355

a(70) in Recurrent Layer:
    1.0e-20 *

    0.6776
         0
    0.6776

a(71) in Recurrent Layer:
    1.0e-20 *

    0.3388
         0
    0.3388

a(72) in Recurrent Layer:
    1.0e-20 *
```

```
        0.1694
             0
        0.1694

a(73) in Recurrent Layer:
    1.0e-21 *

        0.8470
             0
        0.8470

a(74) in Recurrent Layer:
    1.0e-21 *

        0.4235
             0
        0.4235

a(75) in Recurrent Layer:
    1.0e-21 *

        0.2118
             0
        0.2118

a(76) in Recurrent Layer:
    1.0e-21 *

        0.1059
             0
        0.1059

a(77) in Recurrent Layer:
    1.0e-22 *

        0.5294
             0
        0.5294

a(78) in Recurrent Layer:
    1.0e-22 *

        0.2647
             0
        0.2647

a(79) in Recurrent Layer:
    1.0e-22 *

        0.1323
             0
        0.1323

a(80) in Recurrent Layer:
    1.0e-23 *

        0.6617
             0
        0.6617

a(81) in Recurrent Layer:
    1.0e-23 *

        0.3309
```

```
        0
   0.3309

a(82) in Recurrent Layer:
   1.0e-23 *

   0.1654
        0
   0.1654

a(83) in Recurrent Layer:
   1.0e-24 *

   0.8272
        0
   0.8272

a(84) in Recurrent Layer:
   1.0e-24 *

   0.4136
        0
   0.4136

a(85) in Recurrent Layer:
   1.0e-24 *

   0.2068
        0
   0.2068

a(86) in Recurrent Layer:
   1.0e-24 *

   0.1034
        0
   0.1034

a(87) in Recurrent Layer:
   1.0e-25 *

   0.5170
        0
   0.5170

a(88) in Recurrent Layer:
   1.0e-25 *

   0.2585
        0
   0.2585

a(89) in Recurrent Layer:
   1.0e-25 *

   0.1292
        0
   0.1292

a(90) in Recurrent Layer:
   1.0e-26 *

   0.6462
        0
```

```
     0.6462

a(91) in Recurrent Layer:
   1.0e-26 *

     0.3231
          0
     0.3231

a(92) in Recurrent Layer:
   1.0e-26 *

     0.1616
          0
     0.1616

a(93) in Recurrent Layer:
   1.0e-27 *

     0.8078
          0
     0.8078

a(94) in Recurrent Layer:
   1.0e-27 *

     0.4039
          0
     0.4039

a(95) in Recurrent Layer:
   1.0e-27 *

     0.2019
          0
     0.2019

a(96) in Recurrent Layer:
   1.0e-27 *

     0.1010
          0
     0.1010

a(97) in Recurrent Layer:
   1.0e-28 *

     0.5049
          0
     0.5049

a(98) in Recurrent Layer:
   1.0e-28 *

     0.2524
          0
     0.2524

a(99) in Recurrent Layer:
   1.0e-28 *

     0.1262
          0
     0.1262
```

```
a(100) in Recurrent Layer:
   1.0e-29 *

     0.6311
          0
     0.6311
```

Hamming Network result:

```
classify_e1(result_3)
```

Could not classify

```matlab
% Compute ecercise 4
% 4) Crear un W1 con cualquier S, R. Dado un vector de entrada p, muestre
que para
% un valor de epsilon caiga en una clase y para otro valor de epsilon
cambie de clase,
% es decir que el primer valor de epsilon de un resultado de clasificación
y el segundo
% valor de epsilon de un resultado diferente.


prototype_1 = [1; -1; 1];
prototype_2 = [1; 1; -1];
prototype_3 = [-1; 1; 1];
prototypes_4 = [prototype_1, prototype_2, prototype_3];
test_vector = [1; -1; -1];

hammingFruitClassifier_4 = hammingNetwork(prototypes_4);
result_4_1 = hammingFruitClassifier_4.classify(test_vector, 0.3);
```

```
TF in Feed Forward Layer:
    @purelin

W in Feed Forward Layer:
     1    -1     1
     1     1    -1
    -1     1     1

b in Feed Forward Layer:
     3
     3
     3

Feed Forward Layer Result (a1):
     4
     4
     0

TF in Recurrent Layer:
    @poslin

W in Recurrent Layer:
    1.0000   -0.2000   -0.2000
   -0.2000    1.0000   -0.2000
```

```
    -0.2000   -0.2000    1.0000

a(2) in Recurrent Layer:
    3.2000
    3.2000
         0

a(3) in Recurrent Layer:
    2.5600
    2.5600
         0

a(4) in Recurrent Layer:
    2.0480
    2.0480
         0

a(5) in Recurrent Layer:
    1.6384
    1.6384
         0

a(6) in Recurrent Layer:
    1.3107
    1.3107
         0

a(7) in Recurrent Layer:
    1.0486
    1.0486
         0

a(8) in Recurrent Layer:
    0.8389
    0.8389
         0

a(9) in Recurrent Layer:
    0.6711
    0.6711
         0

a(10) in Recurrent Layer:
    0.5369
    0.5369
         0

a(11) in Recurrent Layer:
    0.4295
    0.4295
         0

a(12) in Recurrent Layer:
    0.3436
    0.3436
         0

a(13) in Recurrent Layer:
    0.2749
    0.2749
         0

a(14) in Recurrent Layer:
    0.2199
```

24

```
    0.2199
        0

a(15) in Recurrent Layer:
    0.1759
    0.1759
        0

a(16) in Recurrent Layer:
    0.1407
    0.1407
        0

a(17) in Recurrent Layer:
    0.1126
    0.1126
        0

a(18) in Recurrent Layer:
    0.0901
    0.0901
        0

a(19) in Recurrent Layer:
    0.0721
    0.0721
        0

a(20) in Recurrent Layer:
    0.0576
    0.0576
        0

a(21) in Recurrent Layer:
    0.0461
    0.0461
        0

a(22) in Recurrent Layer:
    0.0369
    0.0369
        0

a(23) in Recurrent Layer:
    0.0295
    0.0295
        0

a(24) in Recurrent Layer:
    0.0236
    0.0236
        0

a(25) in Recurrent Layer:
    0.0189
    0.0189
        0

a(26) in Recurrent Layer:
    0.0151
    0.0151
        0

a(27) in Recurrent Layer:
```

```
         0.0121
         0.0121
             0

a(28) in Recurrent Layer:
         0.0097
         0.0097
             0

a(29) in Recurrent Layer:
         0.0077
         0.0077
             0

a(30) in Recurrent Layer:
         0.0062
         0.0062
             0

a(31) in Recurrent Layer:
         0.0050
         0.0050
             0

a(32) in Recurrent Layer:
         0.0040
         0.0040
             0

a(33) in Recurrent Layer:
         0.0032
         0.0032
             0

a(34) in Recurrent Layer:
         0.0025
         0.0025
             0

a(35) in Recurrent Layer:
         0.0020
         0.0020
             0

a(36) in Recurrent Layer:
         0.0016
         0.0016
             0

a(37) in Recurrent Layer:
         0.0013
         0.0013
             0

a(38) in Recurrent Layer:
         0.0010
         0.0010
             0

a(39) in Recurrent Layer:
       1.0e-03 *

         0.8308
         0.8308
```

```
                     0

a(40) in Recurrent Layer:
   1.0e-03 *

     0.6646
     0.6646
          0

a(41) in Recurrent Layer:
   1.0e-03 *

     0.5317
     0.5317
          0

a(42) in Recurrent Layer:
   1.0e-03 *

     0.4254
     0.4254
          0

a(43) in Recurrent Layer:
   1.0e-03 *

     0.3403
     0.3403
          0

a(44) in Recurrent Layer:
   1.0e-03 *

     0.2722
     0.2722
          0

a(45) in Recurrent Layer:
   1.0e-03 *

     0.2178
     0.2178
          0

a(46) in Recurrent Layer:
   1.0e-03 *

     0.1742
     0.1742
          0

a(47) in Recurrent Layer:
   1.0e-03 *

     0.1394
     0.1394
          0

a(48) in Recurrent Layer:
   1.0e-03 *

     0.1115
     0.1115
          0
```

a(49) in Recurrent Layer:
   1.0e-04 *

     0.8920
     0.8920
         0

a(50) in Recurrent Layer:
   1.0e-04 *

     0.7136
     0.7136
         0

a(51) in Recurrent Layer:
   1.0e-04 *

     0.5709
     0.5709
         0

a(52) in Recurrent Layer:
   1.0e-04 *

     0.4567
     0.4567
         0

a(53) in Recurrent Layer:
   1.0e-04 *

     0.3654
     0.3654
         0

a(54) in Recurrent Layer:
   1.0e-04 *

     0.2923
     0.2923
         0

a(55) in Recurrent Layer:
   1.0e-04 *

     0.2338
     0.2338
         0

a(56) in Recurrent Layer:
   1.0e-04 *

     0.1871
     0.1871
         0

a(57) in Recurrent Layer:
   1.0e-04 *

     0.1497
     0.1497
         0

a(58) in Recurrent Layer:
   1.0e-04 *

      0.1197
      0.1197
           0

a(59) in Recurrent Layer:
   1.0e-05 *

      0.9578
      0.9578
           0

a(60) in Recurrent Layer:
   1.0e-05 *

      0.7662
      0.7662
           0

a(61) in Recurrent Layer:
   1.0e-05 *

      0.6130
      0.6130
           0

a(62) in Recurrent Layer:
   1.0e-05 *

      0.4904
      0.4904
           0

a(63) in Recurrent Layer:
   1.0e-05 *

      0.3923
      0.3923
           0

a(64) in Recurrent Layer:
   1.0e-05 *

      0.3139
      0.3139
           0

a(65) in Recurrent Layer:
   1.0e-05 *

      0.2511
      0.2511
           0

a(66) in Recurrent Layer:
   1.0e-05 *

      0.2009
      0.2009
           0

a(67) in Recurrent Layer:

```
       1.0e-05 *

         0.1607
         0.1607
              0

a(68) in Recurrent Layer:
    1.0e-05 *

         0.1286
         0.1286
              0

a(69) in Recurrent Layer:
    1.0e-05 *

         0.1028
         0.1028
              0

a(70) in Recurrent Layer:
    1.0e-06 *

         0.8228
         0.8228
              0

a(71) in Recurrent Layer:
    1.0e-06 *

         0.6582
         0.6582
              0

a(72) in Recurrent Layer:
    1.0e-06 *

         0.5266
         0.5266
              0

a(73) in Recurrent Layer:
    1.0e-06 *

         0.4212
         0.4212
              0

a(74) in Recurrent Layer:
    1.0e-06 *

         0.3370
         0.3370
              0

a(75) in Recurrent Layer:
    1.0e-06 *

         0.2696
         0.2696
              0

a(76) in Recurrent Layer:
    1.0e-06 *
```

```
       0.2157
       0.2157
            0

a(77) in Recurrent Layer:
   1.0e-06 *

       0.1725
       0.1725
            0

a(78) in Recurrent Layer:
   1.0e-06 *

       0.1380
       0.1380
            0

a(79) in Recurrent Layer:
   1.0e-06 *

       0.1104
       0.1104
            0

a(80) in Recurrent Layer:
   1.0e-07 *

       0.8834
       0.8834
            0

a(81) in Recurrent Layer:
   1.0e-07 *

       0.7067
       0.7067
            0

a(82) in Recurrent Layer:
   1.0e-07 *

       0.5654
       0.5654
            0

a(83) in Recurrent Layer:
   1.0e-07 *

       0.4523
       0.4523
            0

a(84) in Recurrent Layer:
   1.0e-07 *

       0.3619
       0.3619
            0

a(85) in Recurrent Layer:
   1.0e-07 *
```

```
    0.2895
    0.2895
         0
```

a(86) in Recurrent Layer:
   1.0e-07 *

```
    0.2316
    0.2316
         0
```

a(87) in Recurrent Layer:
   1.0e-07 *

```
    0.1853
    0.1853
         0
```

a(88) in Recurrent Layer:
   1.0e-07 *

```
    0.1482
    0.1482
         0
```

a(89) in Recurrent Layer:
   1.0e-07 *

```
    0.1186
    0.1186
         0
```

a(90) in Recurrent Layer:
   1.0e-08 *

```
    0.9486
    0.9486
         0
```

a(91) in Recurrent Layer:
   1.0e-08 *

```
    0.7589
    0.7589
         0
```

a(92) in Recurrent Layer:
   1.0e-08 *

```
    0.6071
    0.6071
         0
```

a(93) in Recurrent Layer:
   1.0e-08 *

```
    0.4857
    0.4857
         0
```

a(94) in Recurrent Layer:
   1.0e-08 *

```
    0.3885
```

```
        0.3885
             0
```

a(95) in Recurrent Layer:
   1.0e-08 *

```
        0.3108
        0.3108
             0
```

a(96) in Recurrent Layer:
   1.0e-08 *

```
        0.2487
        0.2487
             0
```

a(97) in Recurrent Layer:
   1.0e-08 *

```
        0.1989
        0.1989
             0
```

a(98) in Recurrent Layer:
   1.0e-08 *

```
        0.1591
        0.1591
             0
```

a(99) in Recurrent Layer:
   1.0e-08 *

```
        0.1273
        0.1273
             0
```

a(100) in Recurrent Layer:
   1.0e-08 *

```
        0.1019
        0.1019
             0
```

Hamming Network result:

```
result_4_2 = hammingFruitClassifier_4.classify(test_vector, -0.1);
```

TF in Feed Forward Layer:
   @purelin

W in Feed Forward Layer:
```
     1    -1     1
     1     1    -1
    -1     1     1
```

b in Feed Forward Layer:
```
     3
     3
     3
```

Feed Forward Layer Result (a1):

```
        4
        4
        0
```

TF in Recurrent Layer:
    @poslin

W in Recurrent Layer:
    1.0000   -0.6000   -0.6000
   -0.6000   1.0000   -0.6000
   -0.6000   -0.6000   1.0000

a(2) in Recurrent Layer:
    1.6000
    1.6000
         0

a(3) in Recurrent Layer:
    0.6400
    0.6400
         0

a(4) in Recurrent Layer:
    0.2560
    0.2560
         0

a(5) in Recurrent Layer:
    0.1024
    0.1024
         0

a(6) in Recurrent Layer:
    0.0410
    0.0410
         0

a(7) in Recurrent Layer:
    0.0164
    0.0164
         0

a(8) in Recurrent Layer:
    0.0066
    0.0066
         0

a(9) in Recurrent Layer:
    0.0026
    0.0026
         0

a(10) in Recurrent Layer:
    0.0010
    0.0010
         0

a(11) in Recurrent Layer:
   1.0e-03 *

    0.4194
    0.4194
         0

a(12) in Recurrent Layer:
   1.0e-03 *

      0.1678
      0.1678
           0

a(13) in Recurrent Layer:
   1.0e-04 *

      0.6711
      0.6711
           0

a(14) in Recurrent Layer:
   1.0e-04 *

      0.2684
      0.2684
           0

a(15) in Recurrent Layer:
   1.0e-04 *

      0.1074
      0.1074
           0

a(16) in Recurrent Layer:
   1.0e-05 *

      0.4295
      0.4295
           0

a(17) in Recurrent Layer:
   1.0e-05 *

      0.1718
      0.1718
           0

a(18) in Recurrent Layer:
   1.0e-06 *

      0.6872
      0.6872
           0

a(19) in Recurrent Layer:
   1.0e-06 *

      0.2749
      0.2749
           0

a(20) in Recurrent Layer:
   1.0e-06 *

      0.1100
      0.1100
           0

a(21) in Recurrent Layer:

```
    1.0e-07 *

      0.4398
      0.4398
          0

a(22) in Recurrent Layer:
    1.0e-07 *

      0.1759
      0.1759
          0

a(23) in Recurrent Layer:
    1.0e-08 *

      0.7037
      0.7037
          0

a(24) in Recurrent Layer:
    1.0e-08 *

      0.2815
      0.2815
          0

a(25) in Recurrent Layer:
    1.0e-08 *

      0.1126
      0.1126
          0

a(26) in Recurrent Layer:
    1.0e-09 *

      0.4504
      0.4504
          0

a(27) in Recurrent Layer:
    1.0e-09 *

      0.1801
      0.1801
          0

a(28) in Recurrent Layer:
    1.0e-10 *

      0.7206
      0.7206
          0

a(29) in Recurrent Layer:
    1.0e-10 *

      0.2882
      0.2882
          0

a(30) in Recurrent Layer:
    1.0e-10 *
```

```
     0.1153
     0.1153
          0

a(31) in Recurrent Layer:
   1.0e-11 *

     0.4612
     0.4612
          0

a(32) in Recurrent Layer:
   1.0e-11 *

     0.1845
     0.1845
          0

a(33) in Recurrent Layer:
   1.0e-12 *

     0.7379
     0.7379
          0

a(34) in Recurrent Layer:
   1.0e-12 *

     0.2951
     0.2951
          0

a(35) in Recurrent Layer:
   1.0e-12 *

     0.1181
     0.1181
          0

a(36) in Recurrent Layer:
   1.0e-13 *

     0.4722
     0.4722
          0

a(37) in Recurrent Layer:
   1.0e-13 *

     0.1889
     0.1889
          0

a(38) in Recurrent Layer:
   1.0e-14 *

     0.7556
     0.7556
          0

a(39) in Recurrent Layer:
   1.0e-14 *
```

```
        0.3022
        0.3022
             0

a(40) in Recurrent Layer:
   1.0e-14 *

        0.1209
        0.1209
             0

a(41) in Recurrent Layer:
   1.0e-15 *

        0.4836
        0.4836
             0

a(42) in Recurrent Layer:
   1.0e-15 *

        0.1934
        0.1934
             0

a(43) in Recurrent Layer:
   1.0e-16 *

        0.7737
        0.7737
             0

a(44) in Recurrent Layer:
   1.0e-16 *

        0.3095
        0.3095
             0

a(45) in Recurrent Layer:
   1.0e-16 *

        0.1238
        0.1238
             0

a(46) in Recurrent Layer:
   1.0e-17 *

        0.4952
        0.4952
             0

a(47) in Recurrent Layer:
   1.0e-17 *

        0.1981
        0.1981
             0

a(48) in Recurrent Layer:
   1.0e-18 *

        0.7923
```

```
      0.7923
          0

a(49) in Recurrent Layer:
   1.0e-18 *

      0.3169
      0.3169
          0

a(50) in Recurrent Layer:
   1.0e-18 *

      0.1268
      0.1268
          0

a(51) in Recurrent Layer:
   1.0e-19 *

      0.5071
      0.5071
          0

a(52) in Recurrent Layer:
   1.0e-19 *

      0.2028
      0.2028
          0

a(53) in Recurrent Layer:
   1.0e-20 *

      0.8113
      0.8113
          0

a(54) in Recurrent Layer:
   1.0e-20 *

      0.3245
      0.3245
          0

a(55) in Recurrent Layer:
   1.0e-20 *

      0.1298
      0.1298
          0

a(56) in Recurrent Layer:
   1.0e-21 *

      0.5192
      0.5192
          0

a(57) in Recurrent Layer:
   1.0e-21 *

      0.2077
      0.2077
```

```
                    0

a(58) in Recurrent Layer:
   1.0e-22 *

      0.8308
      0.8308
          0

a(59) in Recurrent Layer:
   1.0e-22 *

      0.3323
      0.3323
          0

a(60) in Recurrent Layer:
   1.0e-22 *

      0.1329
      0.1329
          0

a(61) in Recurrent Layer:
   1.0e-23 *

      0.5317
      0.5317
          0

a(62) in Recurrent Layer:
   1.0e-23 *

      0.2127
      0.2127
          0

a(63) in Recurrent Layer:
   1.0e-24 *

      0.8507
      0.8507
          0

a(64) in Recurrent Layer:
   1.0e-24 *

      0.3403
      0.3403
          0

a(65) in Recurrent Layer:
   1.0e-24 *

      0.1361
      0.1361
          0

a(66) in Recurrent Layer:
   1.0e-25 *

      0.5445
      0.5445
          0
```

a(67) in Recurrent Layer:
   1.0e-25 *

     0.2178
     0.2178
         0

a(68) in Recurrent Layer:
   1.0e-26 *

     0.8711
     0.8711
         0

a(69) in Recurrent Layer:
   1.0e-26 *

     0.3484
     0.3484
         0

a(70) in Recurrent Layer:
   1.0e-26 *

     0.1394
     0.1394
         0

a(71) in Recurrent Layer:
   1.0e-27 *

     0.5575
     0.5575
         0

a(72) in Recurrent Layer:
   1.0e-27 *

     0.2230
     0.2230
         0

a(73) in Recurrent Layer:
   1.0e-28 *

     0.8920
     0.8920
         0

a(74) in Recurrent Layer:
   1.0e-28 *

     0.3568
     0.3568
         0

a(75) in Recurrent Layer:
   1.0e-28 *

     0.1427
     0.1427
         0

a(76) in Recurrent Layer:
    1.0e-29 *

      0.5709
      0.5709
           0

a(77) in Recurrent Layer:
    1.0e-29 *

      0.2284
      0.2284
           0

a(78) in Recurrent Layer:
    1.0e-30 *

      0.9134
      0.9134
           0

a(79) in Recurrent Layer:
    1.0e-30 *

      0.3654
      0.3654
           0

a(80) in Recurrent Layer:
    1.0e-30 *

      0.1462
      0.1462
           0

a(81) in Recurrent Layer:
    1.0e-31 *

      0.5846
      0.5846
           0

a(82) in Recurrent Layer:
    1.0e-31 *

      0.2338
      0.2338
           0

a(83) in Recurrent Layer:
    1.0e-32 *

      0.9354
      0.9354
           0

a(84) in Recurrent Layer:
    1.0e-32 *

      0.3741
      0.3741
           0

a(85) in Recurrent Layer:

```
    1.0e-32 *

      0.1497
      0.1497
          0

a(86) in Recurrent Layer:
    1.0e-33 *

      0.5986
      0.5986
          0

a(87) in Recurrent Layer:
    1.0e-33 *

      0.2395
      0.2395
          0

a(88) in Recurrent Layer:
    1.0e-34 *

      0.9578
      0.9578
          0

a(89) in Recurrent Layer:
    1.0e-34 *

      0.3831
      0.3831
          0

a(90) in Recurrent Layer:
    1.0e-34 *

      0.1532
      0.1532
          0

a(91) in Recurrent Layer:
    1.0e-35 *

      0.6130
      0.6130
          0

a(92) in Recurrent Layer:
    1.0e-35 *

      0.2452
      0.2452
          0

a(93) in Recurrent Layer:
    1.0e-36 *

      0.9808
      0.9808
          0

a(94) in Recurrent Layer:
    1.0e-36 *
```

```
        0.3923
        0.3923
             0

a(95) in Recurrent Layer:
   1.0e-36 *

        0.1569
        0.1569
             0

a(96) in Recurrent Layer:
   1.0e-37 *

        0.6277
        0.6277
             0

a(97) in Recurrent Layer:
   1.0e-37 *

        0.2511
        0.2511
             0

a(98) in Recurrent Layer:
   1.0e-37 *

        0.1004
        0.1004
             0

a(99) in Recurrent Layer:
   1.0e-38 *

        0.4017
        0.4017
             0

a(100) in Recurrent Layer:
   1.0e-38 *

        0.1607
        0.1607
             0

Hamming Network result:
```

```
classify_e1(result_4_1)
```

Could not classify

```
classify_e1(result_4_2)
```

Could not classify

Después de 10 intentos (véase el anexo), no se pudo lograr cambiar las predicciones con el valor de épsilon, mi consideración es que no hay forma de lograr esto debido a que solo puede haber un valor con distancia de

Hamming que arroje un resultado, en cambio, se pudo lograr lo solicitado en el ejercicio 3, ya que en caso de que esta distancia sea igual en dos prototipos el algoritmo estará oscilando indefinidamente.

ANEXO

Los valores de epsilon sobre los cuales se intentó lograr la predicción distinta del ejercicio 4 son:

1. e1 = -0.9, e2 = -0.8
2. e1 = -0.7, e2 = -0.6
3. e1 = -0.5, e2 = -0.4
4. e1 = -0.3, e2 = -0.2
5. e1 = -0.1, e2 = 0
6. e1 = -0.85, e2 = -0.75
7. e1 = -0.65, e2 = -0.55
8. e1 = -0.45, e2 = -0.35
9. e1 = -0.25, e2 = -0.15
10. e1 = -0.2, e2 = -0.6

```matlab
% Make interpretations over results rom the book
function classifyFruit(prediction)
    switch(find(prediction))
        case 1
            disp('The fruit is an Orange')
        case 2
            disp('The fruit is an Apple')
        otherwise
            disp('Could not classify')
    end
end

% Make interpretations over results from Exercices
function classify_e1(prediction)
    if isempty(prediction)
        disp('Could not classify')
    else
        switch(find(prediction))
            case 1
                disp('The fruit 1')
            case 2
                disp('The fruit 2')
            case 3
                disp('The fruit 3')
            case 4
                disp('The fruit 4')
            case 5
                disp('The fruit 5')
            case 6
```

```matlab
                disp('The fruit 6')
            case 7
                disp('The fruit 7')
            case 8
                disp('The fruit 8')
            case 9
                disp('The fruit 9')
        end
    end
end
```