Hamming codes

Table of Contents

initialize

```
clc;
clear all;
close all;
```

input data

```
x=randi(2,[1 1000]) - 1;
x1=reshape(x,[250,4])
```

```
x1 =

     1     0     0     1
     0     1     0     0
     1     1     0     0
     0     1     0     1
     1     1     0     1
     1     0     0     0
     0     0     0     0
     0     1     0     1
     0     0     0     0
     0     1     1     1
     0     1     0     1
     1     1     1     1
     0     0     0     0
     1     0     0     0
     1     0     0     1
     1     0     0     1
     0     1     0     1
     1     1     0     1
     0     1     0     1
     1     0     0     0
     0     0     0     1
     0     1     0     0
     0     0     1     0
     1     1     1     0
     0     1     1     1
     0     0     0     1
     1     1     0     1
```

```
0    1    0    1
1    1    1    1
0    1    0    1
1    1    0    1
0    1    0    0
1    1    0    0
1    1    0    0
1    0    1    1
1    0    0    1
0    1    1    1
1    1    1    1
1    0    0    0
1    1    1    1
0    1    1    1
0    1    1    0
0    0    1    1
0    1    0    0
1    1    1    0
1    1    0    0
0    1    0    0
1    0    1    1
0    1    1    0
1    0    0    0
1    0    0    0
0    1    1    0
1    1    1    0
0    1    1    1
1    0    1    0
1    1    0    0
1    0    1    0
1    1    0    1
1    1    1    0
1    1    0    1
0    0    1    1
0    0    1    0
0    0    0    1
0    1    0    1
0    1    0    0
1    1    0    1
1    1    0    1
0    1    1    0
0    0    0    0
1    1    1    1
1    0    0    1
1    0    0    1
1    1    0    0
1    1    0    1
0    1    1    1
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```

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1    1    0    0
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0    1    0    1
0    0    0    1
1    0    1    1
0    1    0    0
0    1    1    0
1    1    1    0
1    1    0    1
0    1    0    0
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0    1    1    1
0    0    0    1
1    0    0    0
```

```
1    0    0    0
1    0    0    0
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0    0    1    0
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1    1    1    0
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1    1    1    1
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1    1    1    0
1    1    1    1
0    0    1    0
1    1    0    1
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1    1    1    0
0    0    1    1
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0    1    0    1
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1    0    1    1
1    0    0    1
0    1    1    1
1    1    0    0
1    0    0    1
1    1    1    0
0    1    0    0
0    1    1    1
1    1    1    0
0    0    1    0
0    0    1    1
1    1    1    0
1    0    1    0
1    0    0    0
1    0    0    0
0    1    1    0
0    0    0    1
0    1    0    0
```

0	0	0	0
1	1	1	0
1	1	1	0
0	0	1	1
1	1	0	0
0	0	0	1
1	1	1	1
0	1	1	1
1	0	1	1
0	0	0	0
1	0	0	0
1	0	1	1
0	0	1	0
1	1	1	1
0	1	0	1
0	1	1	1
1	1	0	0
0	0	1	1
1	1	0	0
0	0	0	0
1	1	0	0
1	0	1	1
1	1	1	1
0	0	0	1
1	1	0	1
1	1	0	0
0	1	1	1
0	1	1	0
1	1	0	1
1	0	0	1
0	0	0	1
0	1	1	1
0	1	1	1
0	1	0	0
0	0	0	0
0	1	1	1
0	1	0	0
0	0	0	0
0	1	1	0
1	1	0	0
0	0	1	1
1	1	1	1
0	1	1	1
0	0	0	0
0	1	1	1
1	1	1	1
1	1	0	1
1	1	1	1
1	0	0	0
1	0	0	1
0	1	0	0
0	1	1	1
0	0	1	1
0	0	0	1

```
1     0     1     0
1     0     0     1
1     0     1     0
1     1     1     0
0     0     0     1
1     0     1     1
1     0     0     0
```

Generator matrix and hamming matrix

```
G=[1 0 0 0 1 1 1;0 1 0 0 1 1 0;0 0 1 0 1 0 1;0 0 0 1 0 1 1];
H=[1 1 1 0 1 0 0;1 1 0 1 0 1 0;1 0 1 1 0 0 1];
k=H';
D=x1(:,:)
cw=D*G
a=cw*k


D =

1     0     0     1
0     1     0     0
1     1     0     0
0     1     0     1
1     1     0     1
1     0     0     0
0     0     0     0
0     1     0     1
0     0     0     0
0     1     1     1
0     1     0     1
1     1     1     1
0     0     0     0
1     0     0     0
1     0     0     1
1     0     0     1
0     1     0     1
1     1     0     1
0     1     0     1
1     0     0     0
0     0     0     1
0     1     0     0
0     0     1     0
1     1     1     0
0     1     1     1
0     0     0     1
1     1     0     1
0     1     0     1
1     1     1     1
0     1     0     1
1     1     0     1
0     1     0     0
```

```
1    1    0    0
1    1    0    0
1    0    1    1
1    0    0    1
0    1    1    1
1    1    1    1
1    0    0    0
1    1    1    1
0    1    1    1
0    1    1    0
0    0    1    1
0    1    0    0
1    1    1    0
1    1    0    0
0    1    0    0
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1    0    0    0
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1	0	0	0
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0    1    1    1
0    0    1    1
0    0    0    1
1    0    1    0
1    0    0    1
1    0    1    0
1    1    1    0
0    0    0    1
```

```
        1       0       1       1
        1       0       0       0



CW  =

        1       0       0       1       1       2       2
        0       1       0       0       1       1       0
        1       1       0       0       2       2       1
        0       1       0       1       1       2       1
        1       1       0       1       2       3       2
        1       0       0       0       1       1       1
        0       0       0       0       0       0       0
        0       1       0       1       1       2       1
        0       0       0       0       0       0       0
        0       1       1       1       2       2       2
        0       1       0       1       1       2       1
        1       1       1       1       3       3       3
        0       0       0       0       0       0       0
        1       0       0       0       1       1       1
        1       0       0       1       1       2       2
        1       0       0       1       1       2       2
        0       1       0       1       1       2       1
        1       1       0       1       2       3       2
        0       1       0       1       1       2       1
        1       0       0       0       1       1       1
        0       0       0       1       0       1       1
        0       1       0       0       1       1       0
        0       0       1       0       1       0       1
        1       1       1       0       3       2       2
        0       1       1       1       2       2       2
        0       0       0       1       0       1       1
        1       1       0       1       2       3       2
        0       1       0       1       1       2       1
        1       1       1       1       3       3       3
        0       1       0       1       1       2       1
        1       1       0       1       2       3       2
        0       1       0       0       1       1       0
        1       1       0       0       2       2       1
        1       1       0       0       2       2       1
        1       0       1       1       2       2       3
        1       0       0       1       1       2       2
        0       1       1       1       2       2       2
        1       1       1       1       3       3       3
        1       0       0       0       1       1       1
        1       1       1       1       3       3       3
        0       1       1       1       2       2       2
        0       1       1       0       2       1       1
        0       0       1       1       1       1       2
        0       1       0       0       1       1       0
        1       1       1       0       3       2       2
        1       1       0       0       2       2       1
        0       1       0       0       1       1       0
        1       0       1       1       2       2       3
```

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1	0	0	0	1	1	1
1	0	0	0	1	1	1
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1	1	1	0	3	2	2
0	1	1	1	2	2	2
1	0	1	0	2	1	2
1	1	0	0	2	2	1
1	0	1	0	2	1	2
1	1	0	1	2	3	2
1	1	1	0	3	2	2
1	1	0	1	2	3	2
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0	0	1	0	1	0	1
0	0	0	1	0	1	1
0	1	0	1	1	2	1
0	1	0	0	1	1	0
1	1	0	1	2	3	2
1	1	0	1	2	3	2
0	1	1	0	2	1	1
0	0	0	0	0	0	0
1	1	1	1	3	3	3
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0	1	1	1	2	2	2
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0	1	1	1	2	2	2
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1	0	0	0	1	1	1
1	0	0	0	1	1	1
0	0	0	0	0	0	0
1	1	0	0	2	2	1
1	0	0	0	1	1	1
1	1	1	1	3	3	3
1	1	1	1	3	3	3
1	0	1	0	2	1	2
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0	1	0	0	1	1	0
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1	1	1	0	3	2	2
0	1	1	0	2	1	1
1	0	1	1	2	2	3
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1	1	1	1	3	3	3
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0	0	0	0	0	0	0
0	1	0	0	1	1	0
0	0	0	0	0	0	0
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1	0	1	0	2	1	2
1	1	0	1	2	3	2

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0	1	1	1	2	2	2
1	1	1	1	3	3	3
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1	0	0	1	1	2	2
0	1	0	1	1	2	1
0	0	1	0	1	0	1
1	0	1	1	2	2	3
1	0	1	0	2	1	2
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0	1	0	1	1	2	1
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0	1	1	0	2	1	1
1	1	1	0	3	2	2
1	1	0	1	2	3	2
0	1	0	0	1	1	0
0	1	0	0	1	1	0
0	1	1	1	2	2	2
0	0	0	1	0	1	1
1	0	0	0	1	1	1
1	0	0	0	1	1	1
1	0	0	0	1	1	1
0	1	0	1	1	2	1
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1	1	0	1	2	3	2
0	0	1	0	1	0	1
1	1	0	1	2	3	2
1	1	1	1	3	3	3
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1	1	0	0	2	2	1
0	0	0	1	0	1	1
0	0	1	1	1	1	2
1	1	0	1	2	3	2
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1	1	1	0	3	2	2
1	1	0	1	2	3	2
0	1	1	0	2	1	1
1	1	1	0	3	2	2
0	0	1	0	1	0	1
1	0	1	1	2	2	3

1	*0*	*0*	*1*	*1*	*2*	*2*
1	*1*	*1*	*1*	*3*	*3*	*3*
0	*1*	*0*	*1*	*1*	*2*	*1*
1	*1*	*1*	*0*	*3*	*2*	*2*
1	*1*	*1*	*1*	*3*	*3*	*3*
0	*0*	*1*	*0*	*1*	*0*	*1*
1	*1*	*0*	*1*	*2*	*3*	*2*
1	*1*	*0*	*1*	*2*	*3*	*2*
1	*0*	*0*	*1*	*1*	*2*	*2*
0	*1*	*1*	*0*	*2*	*1*	*1*
1	*1*	*1*	*0*	*3*	*2*	*2*
0	*0*	*1*	*1*	*1*	*1*	*2*
1	*1*	*1*	*1*	*3*	*3*	*3*
0	*1*	*0*	*1*	*1*	*2*	*1*
0	*0*	*1*	*1*	*1*	*1*	*2*
1	*0*	*1*	*1*	*2*	*2*	*3*
1	*0*	*0*	*1*	*1*	*2*	*2*
0	*1*	*1*	*1*	*2*	*2*	*2*
1	*1*	*0*	*0*	*2*	*2*	*1*
1	*0*	*0*	*1*	*1*	*2*	*2*
1	*1*	*1*	*0*	*3*	*2*	*2*
0	*1*	*0*	*0*	*1*	*1*	*0*
0	*1*	*1*	*1*	*2*	*2*	*2*
1	*1*	*1*	*0*	*3*	*2*	*2*
0	*0*	*1*	*0*	*1*	*0*	*1*
0	*0*	*1*	*1*	*1*	*1*	*2*
1	*1*	*1*	*0*	*3*	*2*	*2*
1	*0*	*1*	*0*	*2*	*1*	*2*
1	*0*	*0*	*0*	*1*	*1*	*1*
1	*0*	*0*	*0*	*1*	*1*	*1*
0	*1*	*1*	*0*	*2*	*1*	*1*
0	*0*	*0*	*1*	*0*	*1*	*1*
0	*1*	*0*	*0*	*1*	*1*	*0*
0	*0*	*0*	*0*	*0*	*0*	*0*
1	*1*	*1*	*0*	*3*	*2*	*2*
1	*1*	*1*	*0*	*3*	*2*	*2*
0	*0*	*1*	*1*	*1*	*1*	*2*
1	*1*	*0*	*0*	*2*	*2*	*1*
0	*0*	*0*	*1*	*0*	*1*	*1*
1	*1*	*1*	*1*	*3*	*3*	*3*
0	*1*	*1*	*1*	*2*	*2*	*2*
1	*0*	*1*	*1*	*2*	*2*	*3*
0	*0*	*0*	*0*	*0*	*0*	*0*
1	*0*	*0*	*0*	*1*	*1*	*1*
1	*0*	*1*	*1*	*2*	*2*	*3*
0	*0*	*1*	*0*	*1*	*0*	*1*
1	*1*	*1*	*1*	*3*	*3*	*3*
0	*1*	*0*	*1*	*1*	*2*	*1*
0	*1*	*1*	*1*	*2*	*2*	*2*
1	*1*	*0*	*0*	*2*	*2*	*1*
0	*0*	*1*	*1*	*1*	*1*	*2*
1	*1*	*0*	*0*	*2*	*2*	*1*
0	*0*	*0*	*0*	*0*	*0*	*0*
1	*1*	*0*	*0*	*2*	*2*	*1*

```
1    0    1    1    2    2    3
1    1    1    1    3    3    3
0    0    0    1    0    1    1
1    1    0    1    2    3    2
1    1    0    0    2    2    1
0    1    1    1    2    2    2
0    1    1    0    2    1    1
1    1    0    1    2    3    2
1    0    0    1    1    2    2
0    0    0    1    0    1    1
0    1    1    1    2    2    2
0    1    1    1    2    2    2
0    1    0    0    1    1    0
0    0    0    0    0    0    0
0    1    1    1    2    2    2
0    1    0    0    1    1    0
0    0    0    0    0    0    0
0    1    1    0    2    1    1
1    1    0    0    2    2    1
0    0    1    1    1    1    2
1    1    1    1    3    3    3
0    1    1    1    2    2    2
0    0    0    0    0    0    0
0    1    1    1    2    2    2
1    1    1    1    3    3    3
1    1    0    1    2    3    2
1    1    1    1    3    3    3
1    0    0    0    1    1    1
1    0    0    1    1    2    2
0    1    0    0    1    1    0
0    1    1    1    2    2    2
0    0    1    1    1    1    2
0    0    0    1    0    1    1
1    0    1    0    2    1    2
1    0    0    1    1    2    2
1    0    1    0    2    1    2
1    1    1    0    3    2    2
0    0    0    1    0    1    1
1    0    1    1    2    2    3
1    0    0    0    1    1    1
```

```
a  =
```

```
2    4    4
2    2    0
4    4    2
2    4    2
4    6    4
2    2    2
0    0    0
2    4    2
0    0    0
4    4    4
```

2	4	2
6	6	6
0	0	0
2	2	2
2	4	4
2	4	4
2	4	2
4	6	4
2	4	2
2	2	2
0	2	2
2	2	0
2	0	2
6	4	4
4	4	4
0	2	2
4	6	4
2	4	2
6	6	6
2	4	2
4	6	4
2	2	0
4	4	2
4	4	2
4	4	6
2	4	4
4	4	4
6	6	6
2	2	2
6	6	6
4	4	4
4	2	2
2	2	4
2	2	0
6	4	4
4	4	2
2	2	0
4	4	6
4	2	2
2	2	2
2	2	2
4	2	2
6	4	4
4	4	4
4	2	4
4	4	2
4	2	4
4	6	4
6	4	4
4	6	4
2	2	4
2	0	2
0	2	2
2	4	2

2	2	0
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4	6	4
4	2	2
0	0	0
6	6	6
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2	4	4
4	4	2
4	6	4
4	4	4
4	4	6
4	4	4
4	2	2
2	2	2
2	2	2
0	0	0
4	4	2
2	2	2
6	6	6
6	6	6
4	2	4
2	2	2
2	2	0
6	4	4
6	4	4
4	2	2
4	4	6
2	0	2
6	6	6
2	2	0
4	2	2
0	0	0
2	2	0
0	0	0
2	4	4
4	2	4
4	6	4
2	2	4
2	4	4
2	2	2
4	2	4
2	2	0
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4	4	6
2	2	2
2	2	0
4	4	4
6	6	6
4	2	2
2	4	4
2	4	2
2	0	2
4	4	6

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0	2	2
2	0	2
2	4	2
0	2	2
4	4	6
2	2	0
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6	4	4
4	6	4
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2	2	0
4	4	4
0	2	2
2	2	2
2	2	2
2	2	2
2	4	2
0	0	0
0	0	0
4	6	4
2	0	2
4	6	4
6	6	6
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0	2	2
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4	6	4
4	6	4
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4	6	4
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6	4	4
2	2	4
6	6	6
2	4	2
2	2	4
4	4	6

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2	4	4
6	4	4
2	2	0
4	4	4
6	4	4
2	0	2
2	2	4
6	4	4
4	2	4
2	2	2
2	2	2
4	2	2
0	2	2
2	2	0
0	0	0
6	4	4
6	4	4
2	2	4
4	4	2
0	2	2
6	6	6
4	4	4
4	4	6
0	0	0
2	2	2
4	4	6
2	0	2
6	6	6
2	4	2
4	4	4
4	4	2
2	2	4
4	4	2
0	0	0
4	4	2
4	4	6
6	6	6
0	2	2
4	6	4
4	4	2
4	4	4
4	2	2
4	6	4
2	4	4
0	2	2
4	4	4
4	4	4
2	2	0
0	0	0
4	4	4
2	2	0

```
     0          0          0
     4          2          2
     4          4          2
     2          2          4
     6          6          6
     4          4          4
     0          0          0
     4          4          4
     6          6          6
     4          6          4
     6          6          6
     2          2          2
     2          4          4
     2          2          0
     4          4          4
     2          2          4
     0          2          2
     4          2          4
     2          4          4
     4          2          4
     6          4          4
     0          2          2
     4          4          6
     2          2          2
```

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