prob5

October 4, 2019

1 EECS16A: Homework 5

1.1 Problem 3: Noisy Images

[1]:
```
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

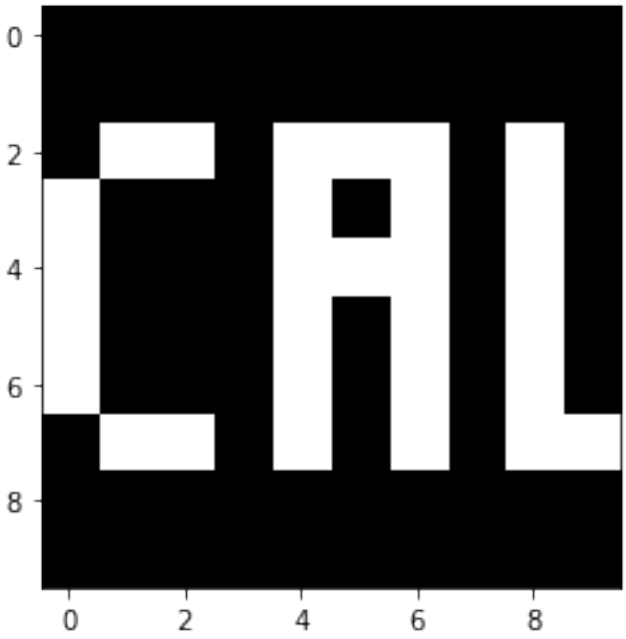
1.1.1 Let's load some data to start off with.

[2]:
```
H3 = np.loadtxt("cond_10e6.txt", delimiter=',').reshape(100,100)
H2 = np.loadtxt("cond_1e3.txt", delimiter=',').reshape(100,100)
H1 = np.eye(100)
img = np.loadtxt("image.txt", delimiter=',').reshape(10,10)
```

1.1.2 The code below displays the image.

[3]:
```
plt.figure(0)
plt.imshow(img,cmap='gray')
```

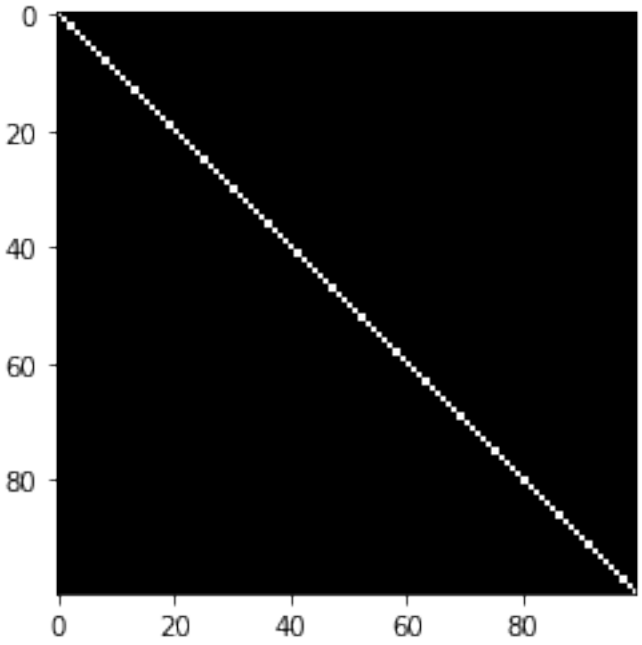
[3]:
```
<matplotlib.image.AxesImage at 0x7ff0944926d8>
```

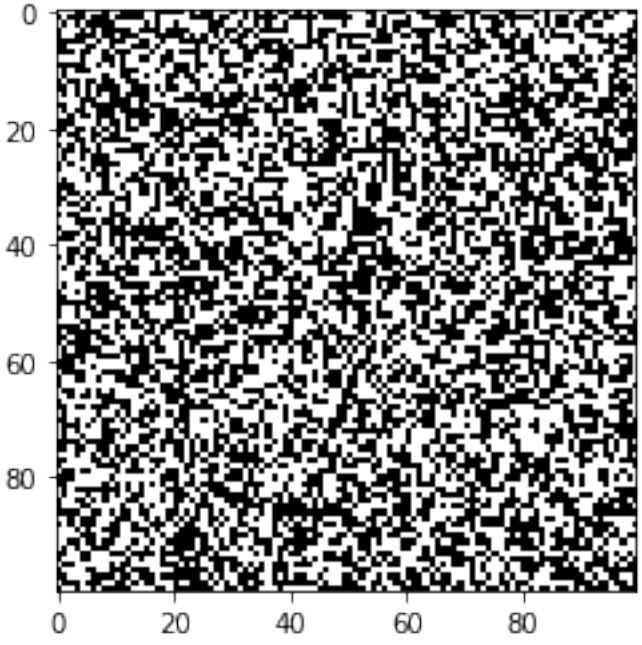


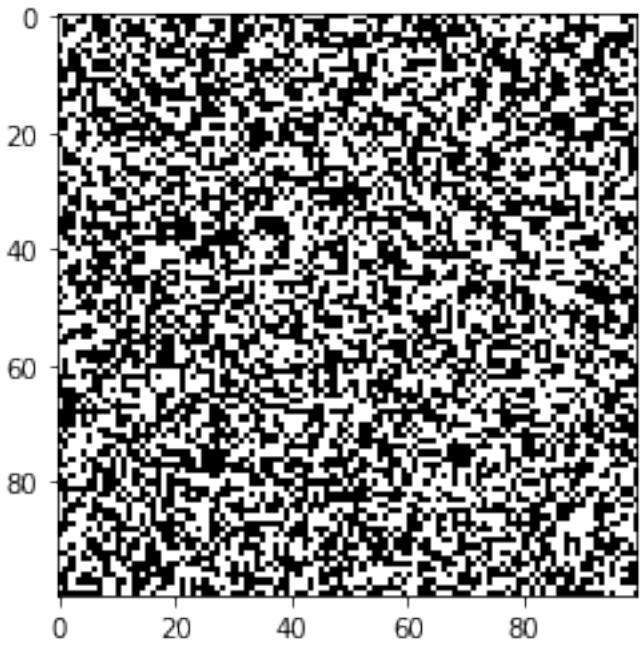
1.1.3 Then, lets display the set of masks

[4]:
```
plt.figure(1)
plt.imshow(H1,cmap='gray')
plt.figure(2)
plt.imshow(H2,cmap='gray')
plt.figure(3)
plt.imshow(H3,cmap='gray')
```

[4]:
```
<matplotlib.image.AxesImage at 0x7ff0940ce2b0>
```


0
20
40
60
80
0
20
40
60
80


0
20
40
60
80
0
20
40
60
80



1.1.4 We'll use numpy.random to make some noise.

[5]:
```
noise = np.random.normal(0.5,0.1)
```

1.1.5 Lets compute the $\vec{b}$ vector for each matrix and add some noise to the $\vec{b}$ vector.

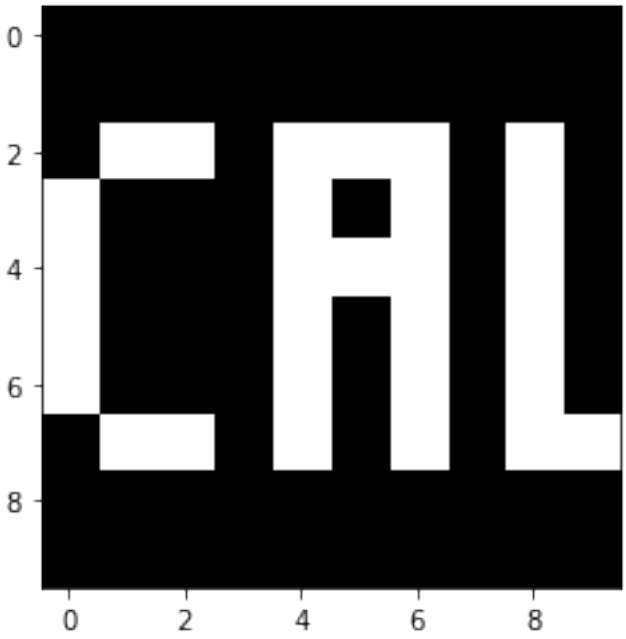
[6]:
```
b1 = H1.dot(img.reshape(100)) + noise
b2 = H2.dot(img.reshape(100)) + noise
b3 = H3.dot(img.reshape(100)) + noise
```

1.1.6 First, let's compute $\vec{x}_1$ after adding noise and find the minimum eigenvalue of H_1.

[7]:
```
x1 = np.linalg.inv(H1).dot(b1)
eigenvalues1 = np.linalg.eig(H1)[0]
print("Is the matrix invertible?", abs(np.linalg.det(H1)) > 0.5)
print("The smallest eigenvalue is:", min(np.absolute(eigenvalues1)))
print("Number of eigenvectors:", len(eigenvalues1))
plt.imshow(x1.reshape(10,10), cmap='gray')
```

```
Is the matrix invertible? True
The smallest eigenvalue is: 1.0
Number of eigenvectors: 100
```

[7]:
```
<matplotlib.image.AxesImage at 0x7ff09406e978>
```

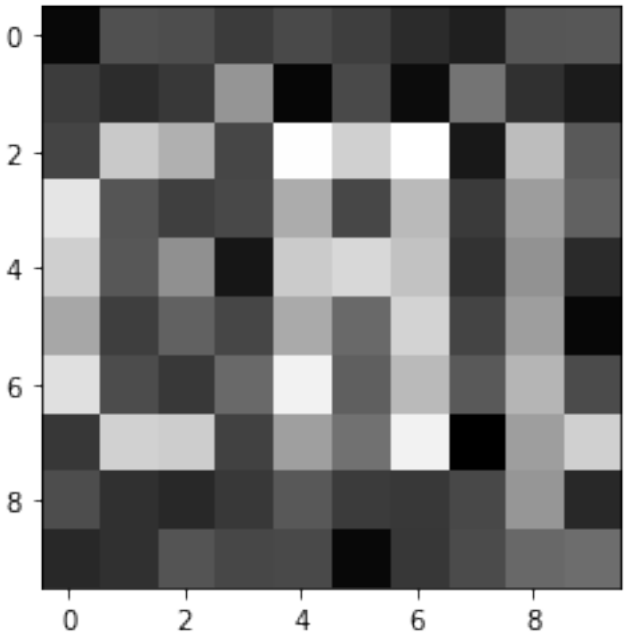


1.1.7 Now let's compute $\vec{x}_2$ and find the minimum eigenvalue of H_2.

[8]:
```
x2 = np.linalg.inv(H2).dot(b2)
eigenvalues2 = np.linalg.eig(H2)[0]
print("Is the matrix invertible?", abs(np.linalg.det(H2)) > 0.5)
print("The smallest eigenvalue is:", min(np.absolute(eigenvalues2)))
print("Number of eigenvectors:", len(eigenvalues2))
plt.imshow(x2.reshape(10,10), cmap='gray')
```

```
Is the matrix invertible? True
The smallest eigenvalue is: 0.2951636330863083
Number of eigenvectors: 100
```

[8]:
```
<matplotlib.image.AxesImage at 0x7ff0902abe10>
```

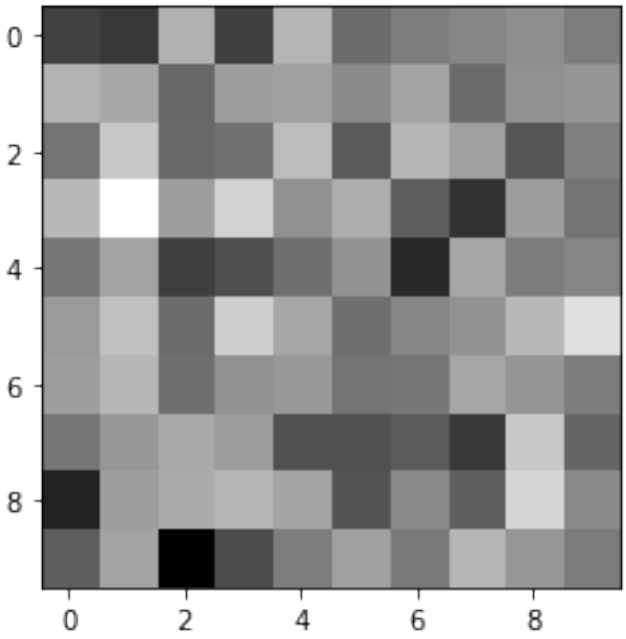


1.1.8 Now let's compute $\vec{x}_3$ and find the minimum eigenvalue of H_3.

[9]:
```
x3 = np.linalg.inv(H3).dot(b3)
eigenvalues3 = np.linalg.eig(H3)[0]
print("Is the matrix invertible?", abs(np.linalg.det(H3)) > 0.5)
print("The smallest eigenvalue is:", min(np.absolute(eigenvalues3)))
print("Number of eigenvectors:", len(eigenvalues3))
plt.imshow(x3.reshape(10,10), cmap='gray')
```

```
Is the matrix invertible? True
The smallest eigenvalue is: 1.2184217528732574e-05
Number of eigenvectors: 100
```

[9]:
```
<matplotlib.image.AxesImage at 0x7ff09028e320>
```



1.2 Problem 5: Page Rank

[10]:
```
# Though it is not required you may use iPython for your calculations in parts␣
↪(c) and (g)
```