Untitled7

October 26, 2019

[52]:
```
def fun(X,omega,tau,step):
    a    = np.zeros_like(X)
    z    = np.zeros_like(X)
    znew = np.zeros_like(X)
    count = 0
    while count<10000 or np.linalg.norm(z-znew)>1e-2:
        count += 1
        z = znew
        u,s,v = np.linalg.svd(z,full_matrices=False)
        s_tau = np.zeros_like(s)
        for i in range(s.size):
            if s[i]>tau:
                s_tau[i] = s[i]-tau
            elif s[i]<-tau:
                s_tau[i] = s[i]+tau
            else:
                s_tau[i] = 0
        a = np.dot(np.dot(u,np.diag(s_tau)),v)
        a_filter = np.copy(a)*omega

        znew = z+step*(X-a_filter)


    return a,z,znew
```

[53]:
```
import csv
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np


X1 = pd.read_csv("M1.csv").as_matrix().reshape(-1).T
X2 = pd.read_csv("M2.csv").as_matrix().reshape(-1).T
X3 = pd.read_csv("M3.csv").as_matrix().reshape(-1).T
X4 = pd.read_csv("M4.csv").as_matrix().reshape(-1).T
X5 = pd.read_csv("M5.csv").as_matrix().reshape(-1).T
X6 = pd.read_csv("M6.csv").as_matrix().reshape(-1).T
```

```
X7 = pd.read_csv("M7.csv").as_matrix().reshape(-1).T
X8 = pd.read_csv("M8.csv").as_matrix().reshape(-1).T
X9 = pd.read_csv("M9.csv").as_matrix().reshape(-1).T
X10= pd.read_csv("M10.csv").as_matrix().reshape(-1).T
X = np.array([X1,X2,X3,X4,X5,X6,X7,X8,X9,X10]).T.astype(float)
# total number of data 320880

from numpy import random

print ("original")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 10% of missing
col = np.array([0,1,2,3,4,5,6,7,8,9])

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%10 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

error = []
error.append(0)
A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
```

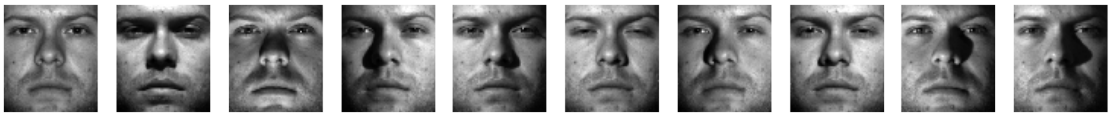
```
plt.show()


# 20% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*2)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%20 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 30% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*3)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%30 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
```

```
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 40% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*4)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%40 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()
```

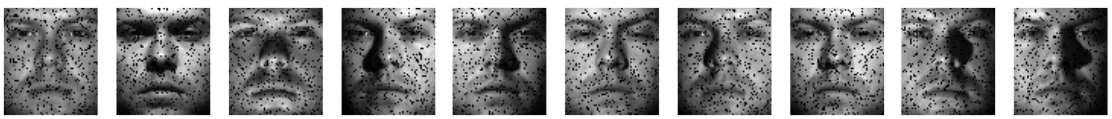
```
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:7:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  import sys
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:8:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
```

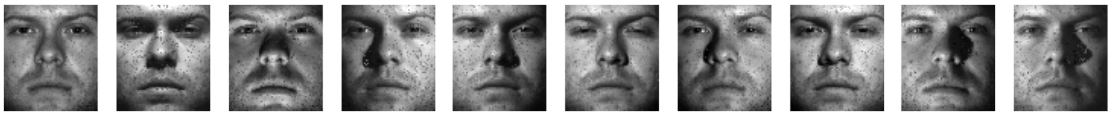
```
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:9:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  if __name__ == '__main__':
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:10:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  # Remove the CWD from sys.path while we load stuff.
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:11:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  # This is added back by InteractiveShellApp.init_path()
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:12:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  if sys.path[0] == '':
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:13:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  del sys.path[0]
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:14:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.

/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:15:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  from ipykernel import kernelapp as app
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:16:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  app.launch_new_instance()
```

original

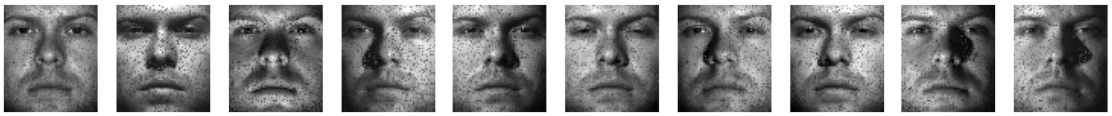


%10 missing

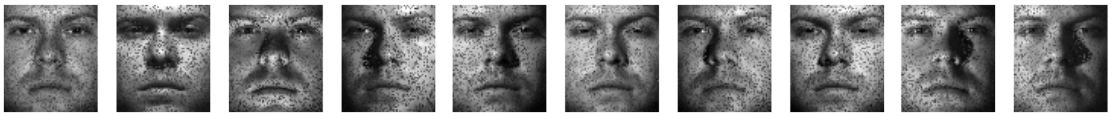




%20 missing

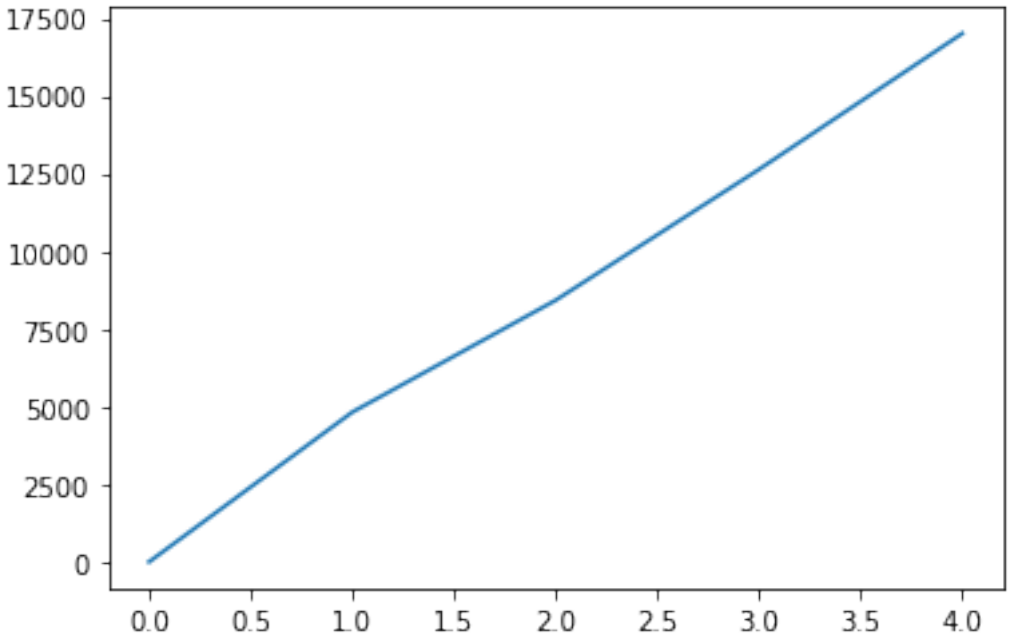


%30 missing



%40 missing

[54]:
```
plt.plot(error)
plt.show()
```



[55]:
```
X1 = pd.read_csv("H1.csv").as_matrix().reshape(-1).T
X2 = pd.read_csv("H2.csv").as_matrix().reshape(-1).T
X3 = pd.read_csv("H3.csv").as_matrix().reshape(-1).T
X4 = pd.read_csv("H4.csv").as_matrix().reshape(-1).T
X5 = pd.read_csv("H5.csv").as_matrix().reshape(-1).T
X6 = pd.read_csv("H6.csv").as_matrix().reshape(-1).T
X7 = pd.read_csv("H7.csv").as_matrix().reshape(-1).T
X8 = pd.read_csv("H8.csv").as_matrix().reshape(-1).T
X9 = pd.read_csv("H9.csv").as_matrix().reshape(-1).T
X10= pd.read_csv("H10.csv").as_matrix().reshape(-1).T
X = np.array([X1,X2,X3,X4,X5,X6,X7,X8,X9,X10]).T.astype(float)

# total number of data 320880
```

```
from numpy import random

print ("original")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 10% of missing
col = np.array([0,1,2,3,4,5,6,7,8,9])

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%10 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

error = []
error.append(0)
A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 20% of missing

omega = np.ones_like(X)
for j in col:
```

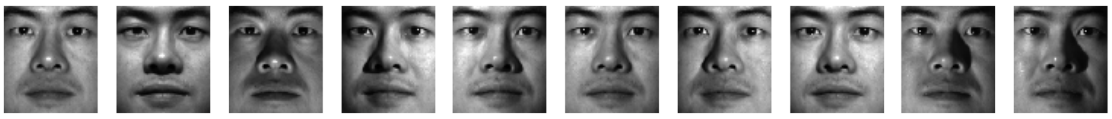
```
    row = random.randint(0,32088,3208*2)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%20 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 30% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*3)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%30 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
```

```
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 40% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*4)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%40 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()



plt.plot(error)
plt.show()
```

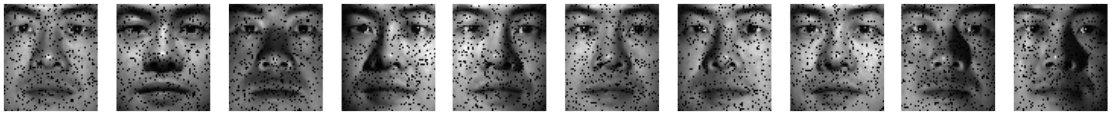
```
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:1:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  """Entry point for launching an IPython kernel.
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:2:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.

/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:3:
FutureWarning: Method .as_matrix will be removed in a future version. Use
```

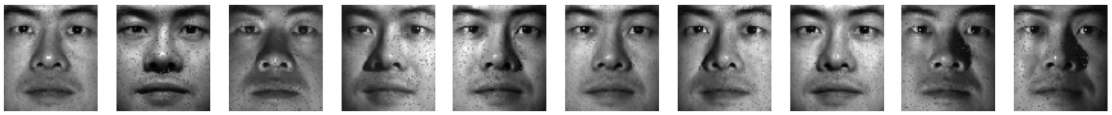
```
.values instead.
  This is separate from the ipykernel package so we can avoid doing imports
until
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:4:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  after removing the cwd from sys.path.
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:5:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  """
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:6:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.

/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:7:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  import sys
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:8:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.

/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:9:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  if __name__ == '__main__':
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:10:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  # Remove the CWD from sys.path while we load stuff.
```

original

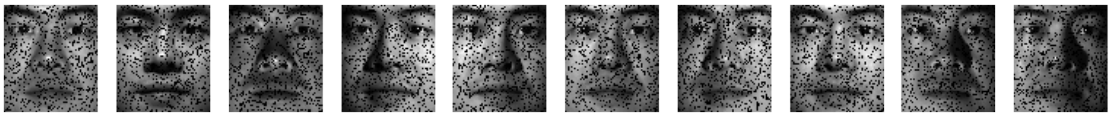


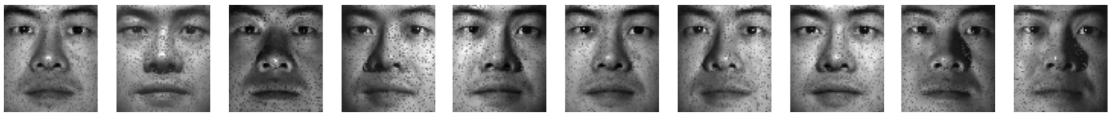
%10 missing



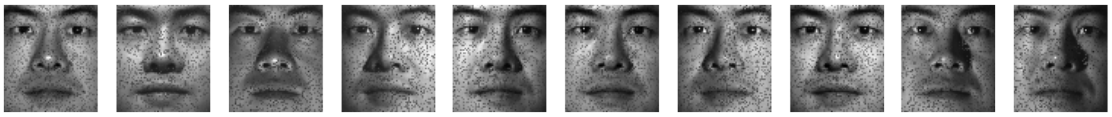


%20 missing

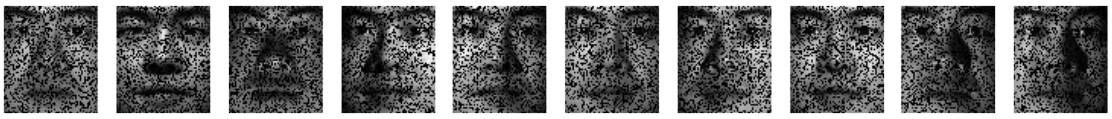


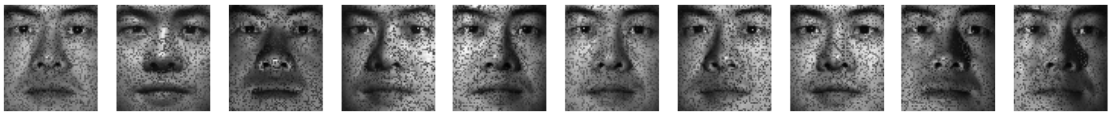


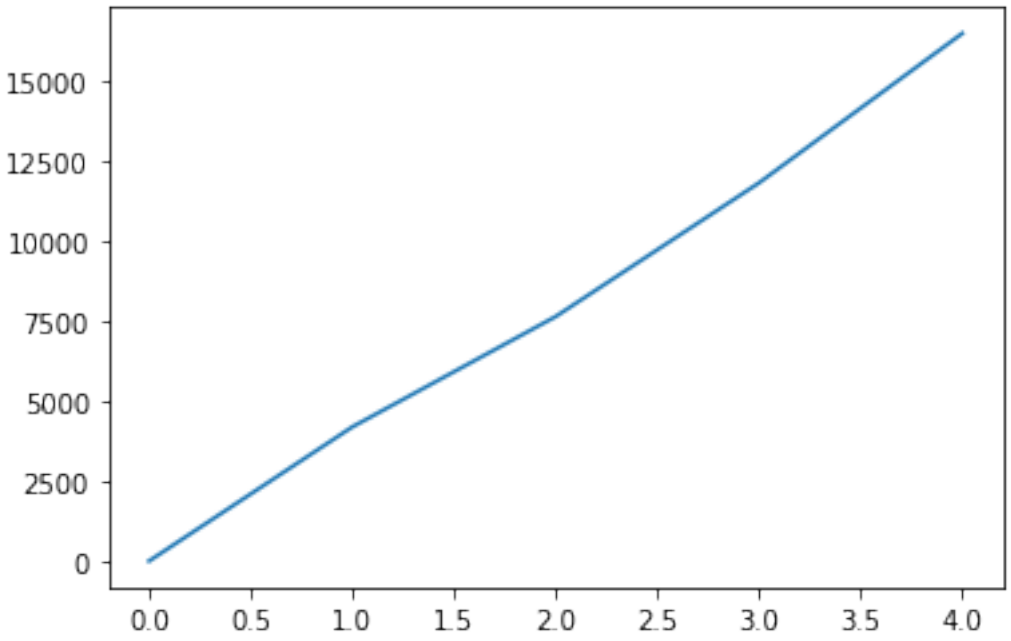
%30 missing



%40 missing







[56]:
```
X1 = pd.read_csv("F1.csv").as_matrix().reshape(-1).T
X2 = pd.read_csv("F2.csv").as_matrix().reshape(-1).T
X3 = pd.read_csv("F3.csv").as_matrix().reshape(-1).T
X4 = pd.read_csv("F4.csv").as_matrix().reshape(-1).T
X5 = pd.read_csv("F5.csv").as_matrix().reshape(-1).T
X6 = pd.read_csv("F6.csv").as_matrix().reshape(-1).T
X7 = pd.read_csv("F7.csv").as_matrix().reshape(-1).T
X8 = pd.read_csv("F8.csv").as_matrix().reshape(-1).T
X9 = pd.read_csv("F9.csv").as_matrix().reshape(-1).T
X10= pd.read_csv("F10.csv").as_matrix().reshape(-1).T
X = np.array([X1,X2,X3,X4,X5,X6,X7,X8,X9,X10]).T.astype(float)

# total number of data 320880

from numpy import random

print ("original")
```

```
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 10% of missing
col = np.array([0,1,2,3,4,5,6,7,8,9])

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%10 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

error = []
error.append(0)
A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 20% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*2)
    for i in row:
        omega[i,j]=0
```

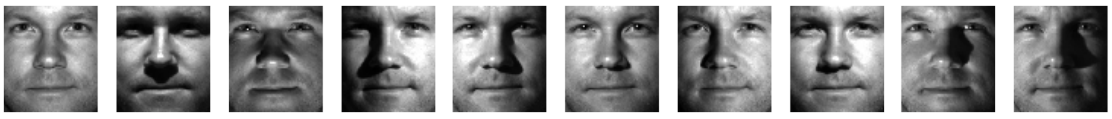
```
X_missing = X.copy()*omega

print ("%20 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()


# 30% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*3)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%30 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()
```

```
# 40% of missing

omega = np.ones_like(X)
for j in col:
    row = random.randint(0,32088,3208*4)
    for i in row:
        omega[i,j]=0
X_missing = X.copy()*omega

print ("%40 missing")
colplot,rowplot = 10,1
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(X_missing[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()

A,Z,Z_new = fun(X_missing,omega,20000,0.1)
error.append(np.linalg.norm(A-X))
fig = plt.figure(figsize=(13,13))
for i in range(1,colplot*rowplot+1):
    fig.add_subplot(rowplot,colplot,i)
    plt.imshow(A[:,i-1].reshape(191,168),cmap="gray")
    plt.axis("off")
plt.show()



plt.plot(error)
plt.show()
```

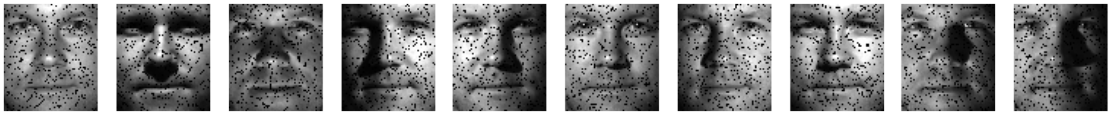
```
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:1:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  """Entry point for launching an IPython kernel.
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:2:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.

/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:3:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  This is separate from the ipykernel package so we can avoid doing imports
until
```

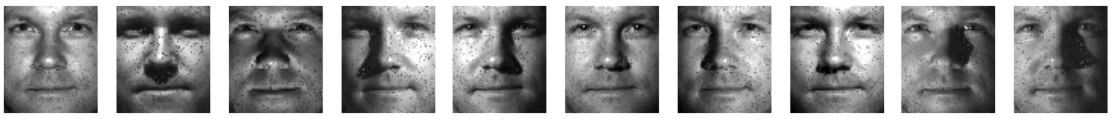
```
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:4:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  after removing the cwd from sys.path.
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:5:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  """
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:6:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.

/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:7:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  import sys
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:8:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.

/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:9:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  if __name__ == '__main__':
/Users/boyaozhu/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:10:
FutureWarning: Method .as_matrix will be removed in a future version. Use
.values instead.
  # Remove the CWD from sys.path while we load stuff.
```

original



%10 missing





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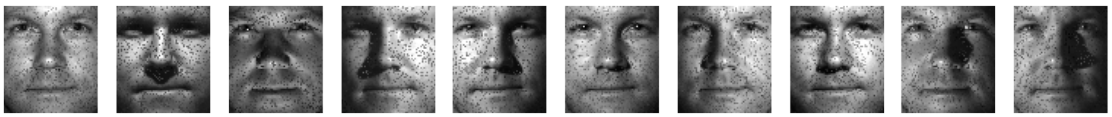

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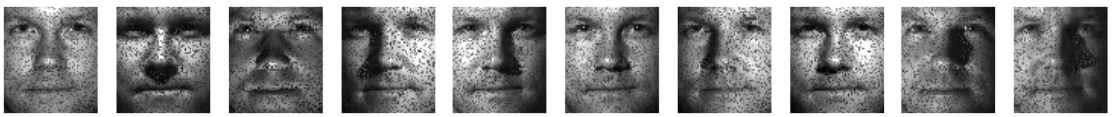

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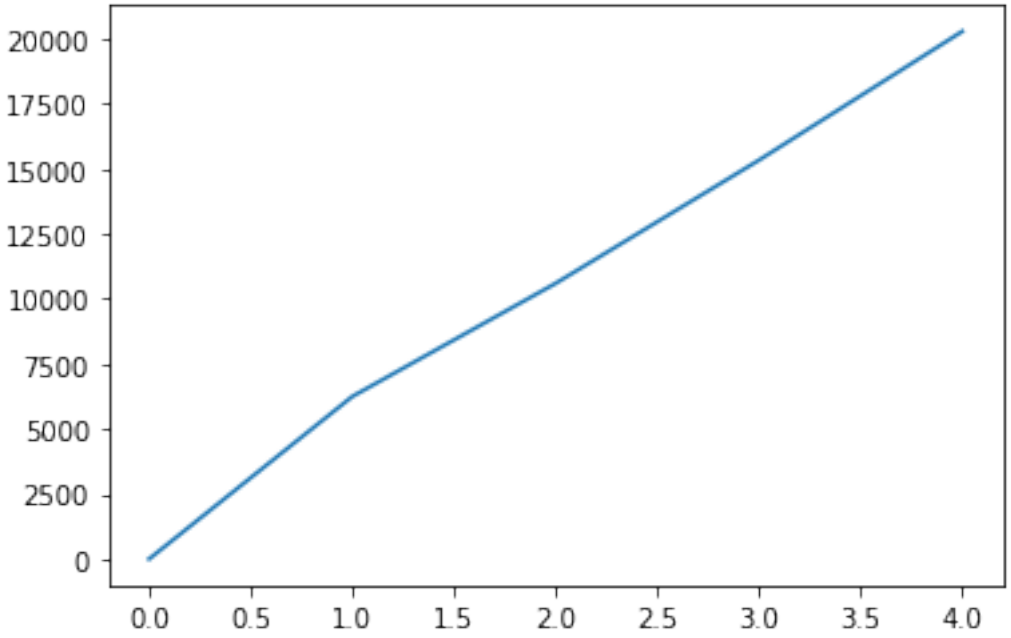
20000
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12500
10000
7500
5000
2500
0
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0.5
1.0
1.5
2.0
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3.0
3.5
4.0

[ ]: